MARINE ENGINEERING.

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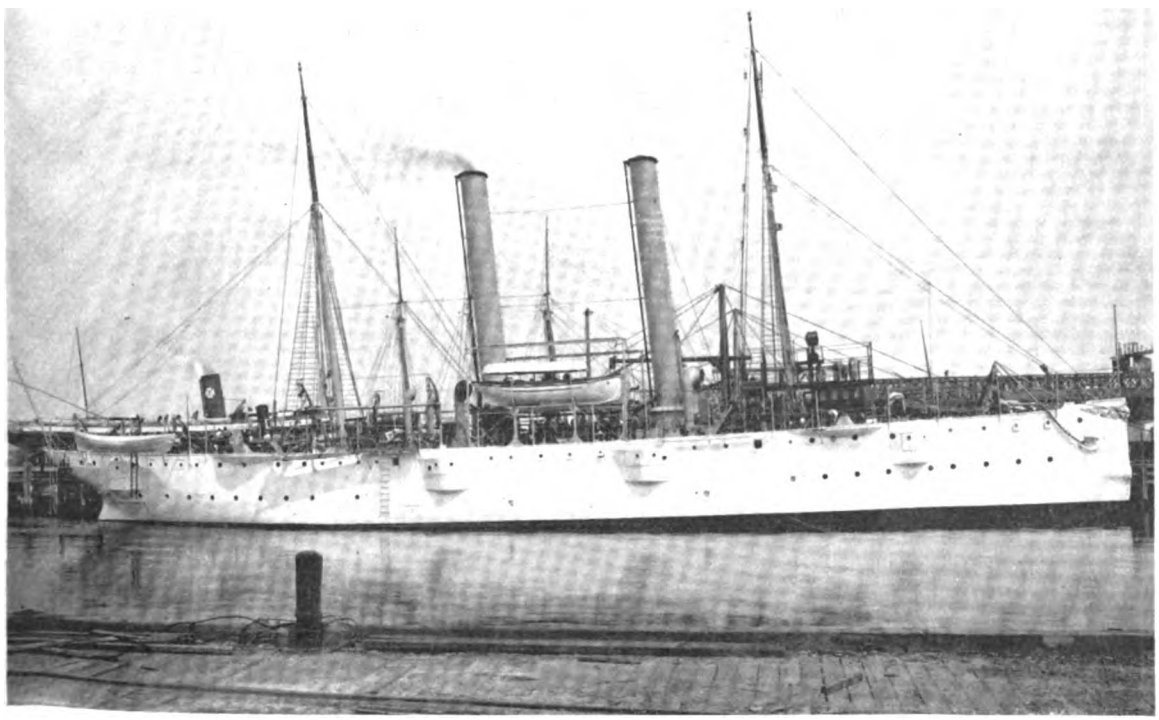
U. S. TWIN-SCREW GUNBOAT NASHVILLE FOR SERVICE IN ASIATIC WATERS.

One of the most interesting of the smaller vessels which have recently been added to the Navy is the steel twin-screw gunboat Nashville, built by the Newport News Shipbuilding and Dry Dock Co., at Newport News, Va. To the engineer especially her machinery equipment is of more than usual interest, in that it consists not only of a combination of quadruple and triple expansion engines, but of Scotch and water-tube boilers. From the exterior views here presented it will be seen that the Nashville is a very handsome vessel, clean cut and trim. Her funnels are unusually long and consequently slender looking, but this is offset by the two pole masts, so that a very smart boat is the result. Her general dimensions are: Length between perpendiculars 220 ft., over all 233 ft. 8 in., beam 38 ft., depth of hold 15 ft. 10 in. On a draught of 11 ft. her displacement is 1,372 tons. The contract for the construction of the Nashville, ready for sea, exclusive of armament, was $280,000, and on her trial trip, when her corrected speed was 16.29 knots, she earned a bonus of $45,980 for her builders. She recently went into commission at the Norfolk Navy Yard, to do patrol duty in Key West waters, on the look-out for Cuban filibusters. Before long, however, she will likely be ordered to the China station.



U. S. TWIN-SCREW GUNBOAT NASHVILLE GETTING READY FOR SEA.

The interior arrangements can readily be seen in the longitudinal section published herewith. The Nashville has three decks, and almost straight back, with the upper deck flush right fore and aft. On this deck there are four 4-in., rapid-fire guns, protected by shields, and it is used for working the

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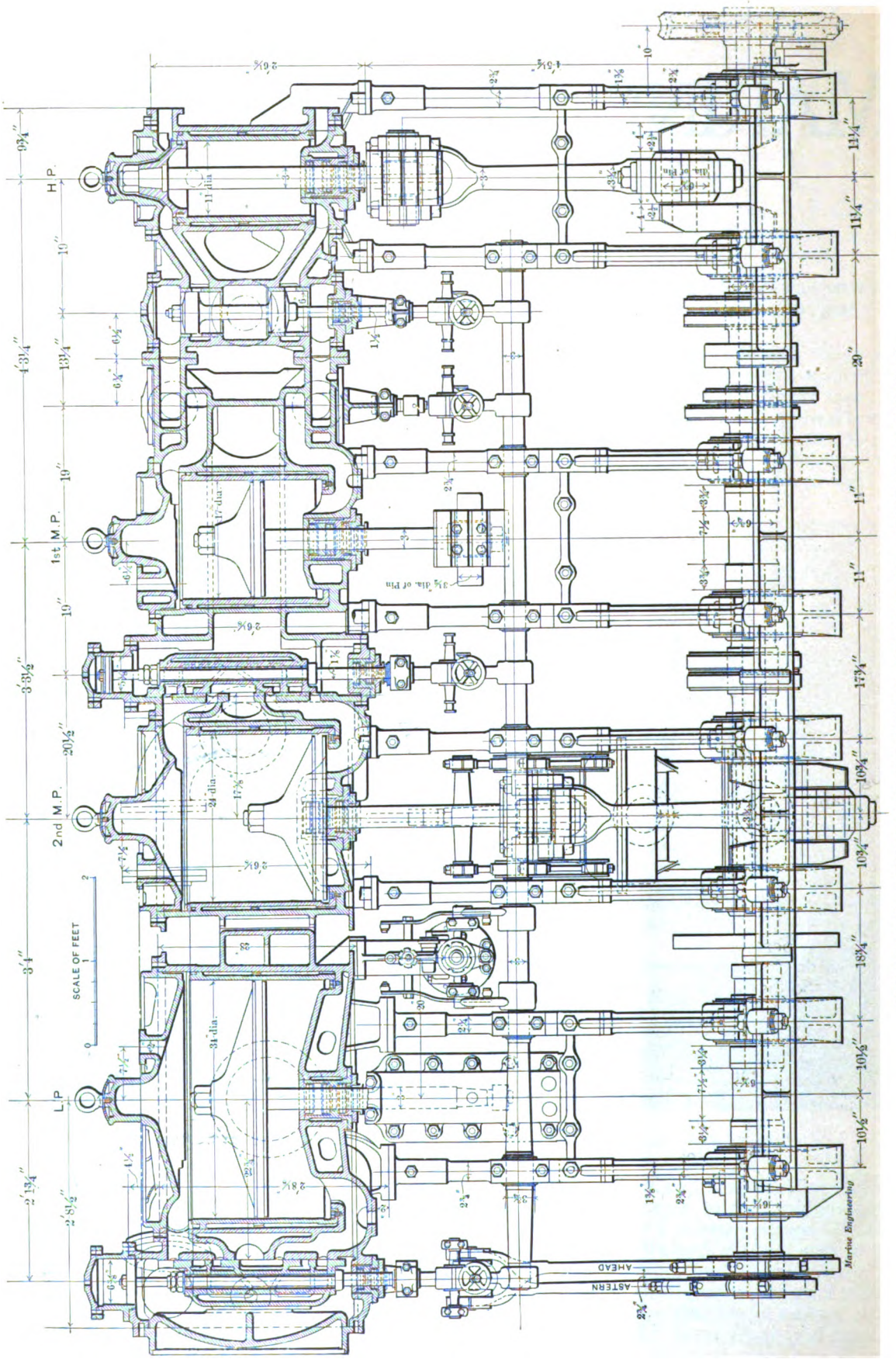

TWIN-SCREW QUADRUPLE-EXPANSION ENGINES U.S. GUNBOAT NASHVILLE.
(*Starboard Engine.*)

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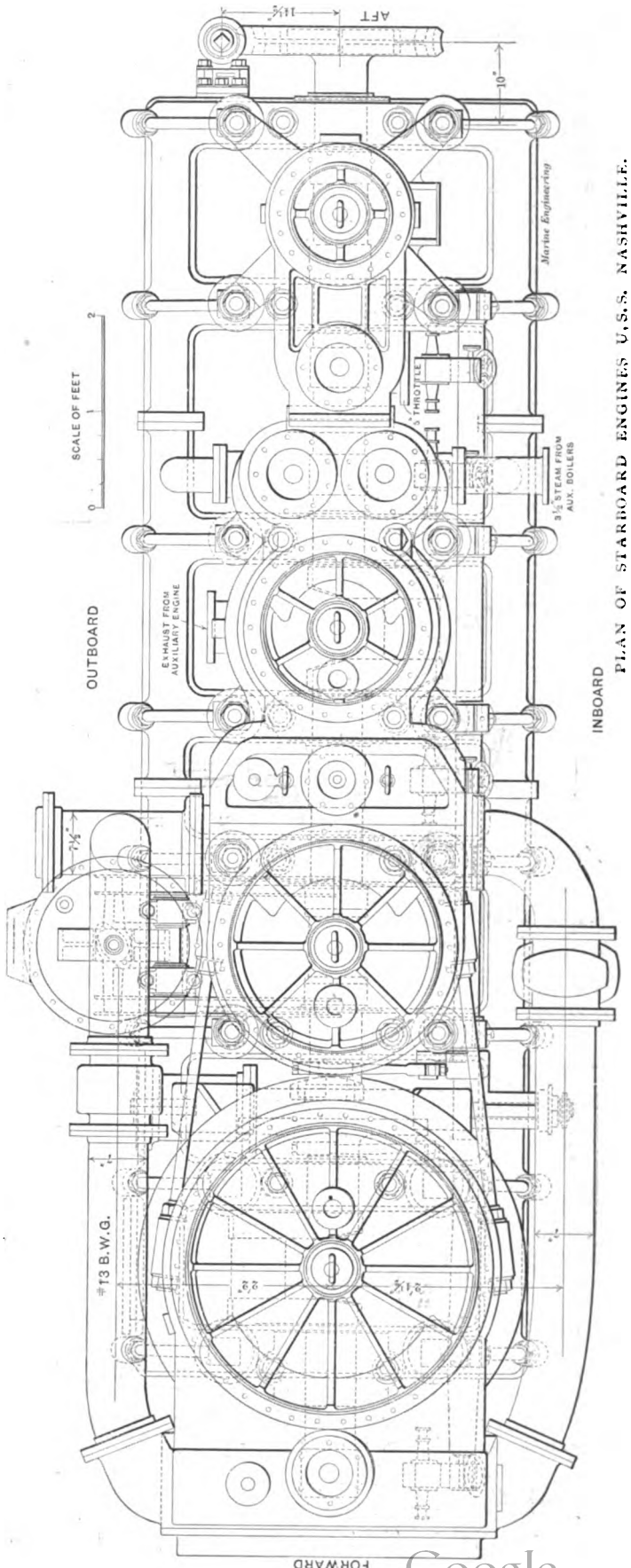
ship. The main deck contains the officers' rooms and executive offices, and also the galley and pantries. On the main deck there are four 4-in., rapid-fire guns in sponsons, protected by 2 1-4 in. nickel steel armor. There are also four 6-pounder quick-fire guns in sponsons on this deck. Two 1-pounders and two machine guns are carried on carriages for fitting in boats or use ashore. Below on the berth deck the crew are housed forward. The bunkers are carried up alongside the machinery spaces on this deck. Below, the engine rooms extend to the inner bottom in this part of the ship, which is carried up to the water-tight sloping deck, and the spaces between the skins are used for fresh-water tanks. On the berth deck the dynamo room, and machine shop, and wash rooms for firemen and machinists, are located between the smoke pipes. Forward and aft of the machinery spaces there are crew's and petty officers' quarters and various store rooms. Below this deck there are ammunition and store rooms and the trimming tanks at the ends. The Nashville is equipped with nine boats, including a 30 ft. steam cutter. It was originally intended that she should carry torpedoes, and a bow port was fitted, but when she was equipped the gear was not put aboard. Below the main deck and including the double bottom under the machinery spaces there are 53 water-tight compartments in the ship.

The machinery consists of two sets of vertical four-cylinder quadruple expansion engines, together with all necessary auxiliaries, and four main boilers of the Yarrow type, and two auxiliary single-ended, single-furnace Scotch boilers. Drawings of the main engines are here given.

When steaming at full speed with quadruple expansion, the main engines run at 300 revolutions per minute taking steam at 250 lbs. pressure per sq. in. in the high pressure valve chest, from the Yarrow boilers, and steam at 160 lbs. pressure per sq. in. in the 1st I. P. receiver, from the Scotch boilers. The engines are fitted with the low pressure cylinder forward, with disconnecting couplings between the L. P. and 2d I. P. cranks. By this arrangement, when cruising at low speeds the L. P. cranks can be disconnected, and the engines run triple expansion by turning steam from the Scotch boilers into the high pressure valve chest. The piping is arranged so that a check valve in position prevents the possibility of the higher pressure steam from the Yarrow boilers under any circumstances flowing into the Scotch boilers. In design the engines are very strong and compact as will be noticed in the engravings, and in workmanship they are beautiful



PLAN OF STARBOARD ENGINES U.S.S. NASHVILLE.

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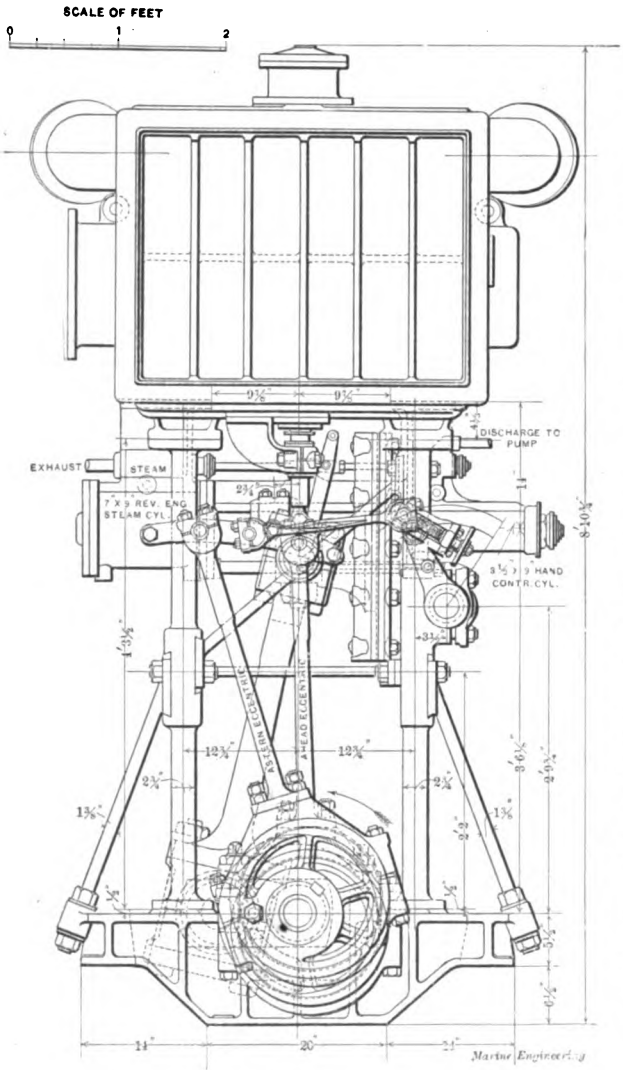
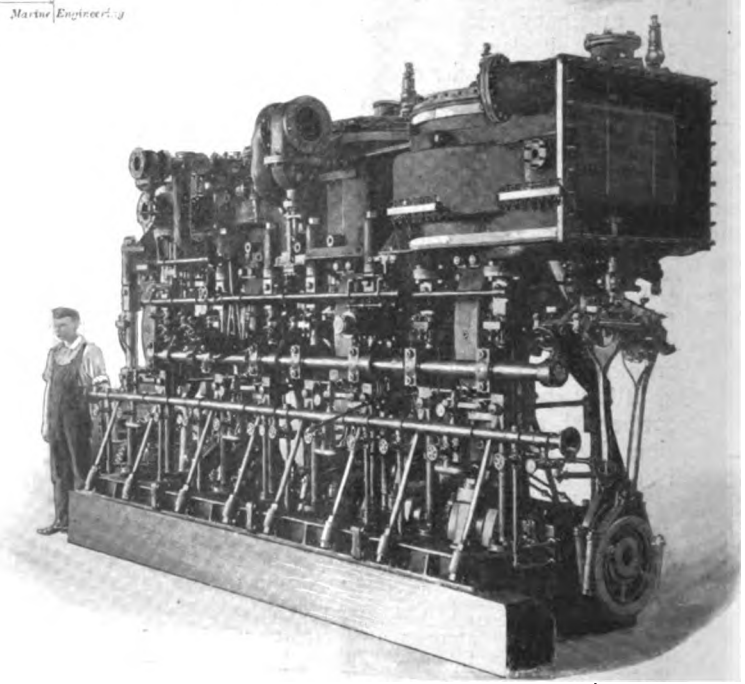


END ELEVATION L. P. ENGINE

specimens of mechanical skill. They are rights and lefts with cylinders 11 in., 17 in., 24 in., and 34 in. and 18 in. stroke. The cranks are set 90 deg. apart, the H. P. leading and the others following in regular sequence. Each engine is fitted with one high pressure piston valve 6 in. dia., two 1st I. P. piston valves 6 in. dia., one 2d I. P. double-ported slide valve 26 in. by 24 in., and one low pressure double ported slide valve 37 in. by 24 in. The cylinders are of fine cast iron, with barrels 11-16 in. thick, fitted with liners of close grained cast iron 5-8 in. thick bored vertically in place.

All except the high-pressure are fitted with jackets on lower heads and bodies. The linear clearance in each cylinder is about 5-8-in., divided between the two ends. The piston valve chests are also fitted with liners, and relief valves are fitted on the intermediate and low-pressure chests. The valves are of cast iron, and balance pistons are fitted to the 2d I. P. and L. P. valves. The cylinders are supported by wrought steel flanged columns, carrying the crosshead guides and stiffened with steel tie rods, as shown in the photograph. Composition relief valves, 2 in. dia., are fitted on all cylinders, with casings and drain pipes. The main cylinders and valve chests are clothed with magnesia and lagged with black walnut, secured with brass bands, making a very artistic job. The bed plates are steel castings of I section, in four parts, bolted together and stiffened with ribs, and secured to the engine keelsons by 1 in. forged steel bolts. The pistons are of cast steel dished, each having one packing ring, 1 1-8 in. by 1-2 in., of cast iron sprung into position. The rods are oil-tempered forged steel, 3-in. dia., and are ground true. They work in composition lined stuffing boxes fitted with Watson's metallic packing, which is also used for the valve stem boxes. The H. P. and 1st I. P. valve stems are 1 1-2 in. dia., reduced to 1 1-8 where they pass through the valves, and the 2d I. P. and L. P. are 1 7-8 in. dia., reduced to 1 1-2 in. The crossheads are fitted with manganese bronze slippers, working against white metal on the ahead slides, which measure 10 1-2 in. by 8 in. The pins are 3 1-2 in. dia. by 4 in. long. The crosshead guides are of cast iron, bolted at the top to lugs cast on the bottoms of the cylinders and at the bottom to forged steel cross bars, secured to the engine columns. They are single slides, with metal lips to take the thrust when backing. They



INBOARD VIEW PORT ENGINES U.S.S. NASHVILLE.

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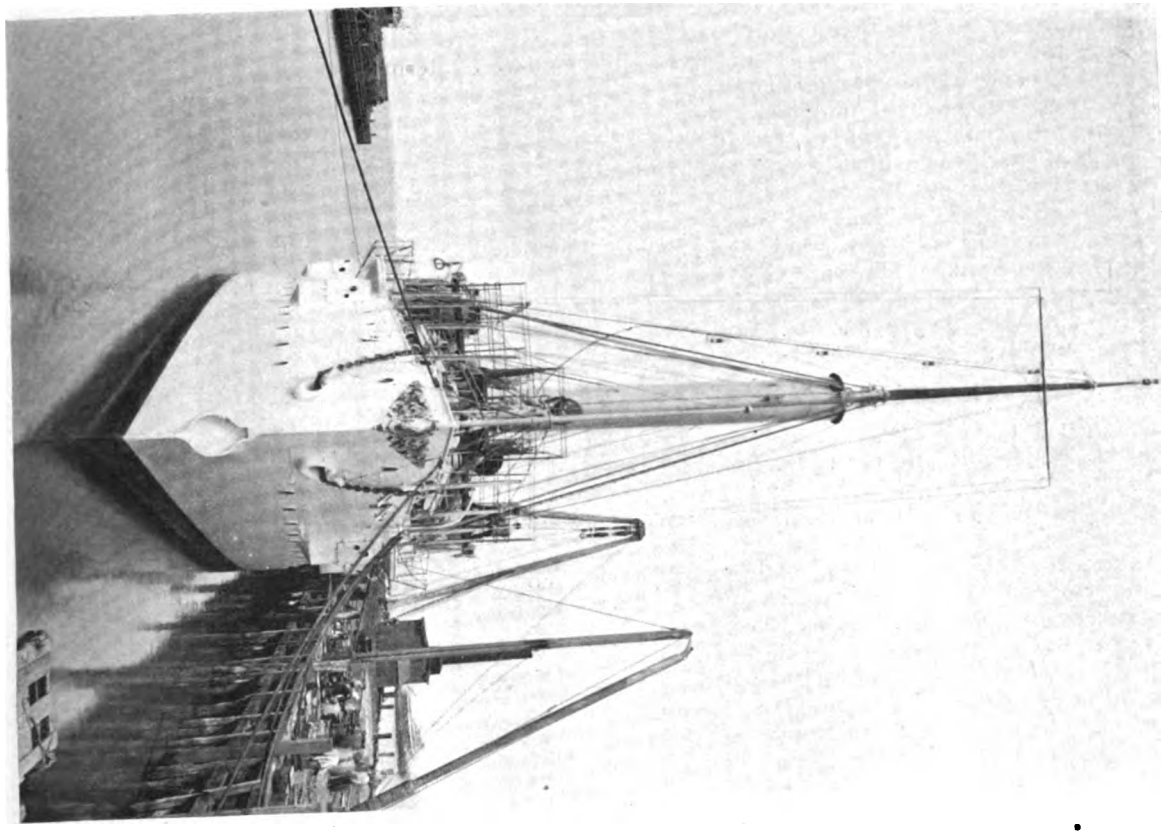
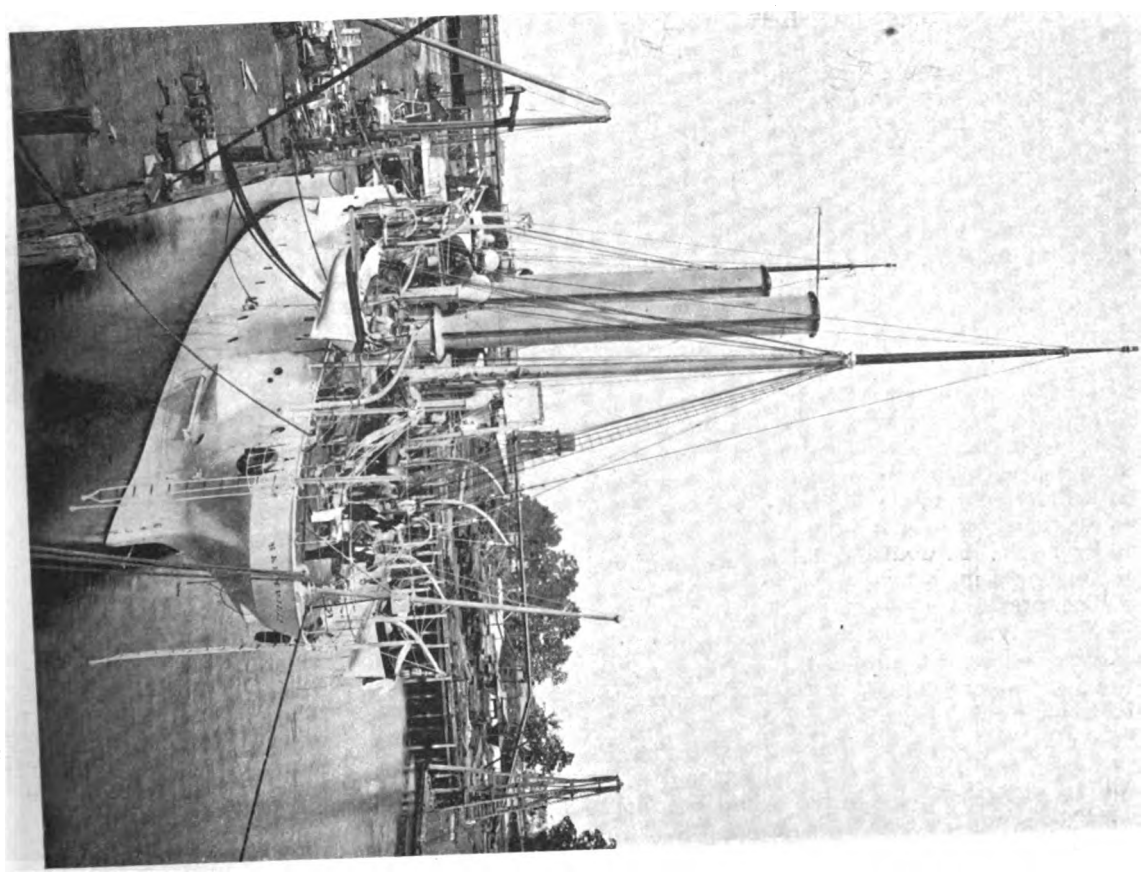


BOW VIEW U.S. TWIN-SCREW GUNBOAT NASHVILLE.

(From Photograph by Rau & Shaw, Newport News, Va.)



STERN VIEW U.S. TWIN-SCREW GUNBOAT NASHVILLE.

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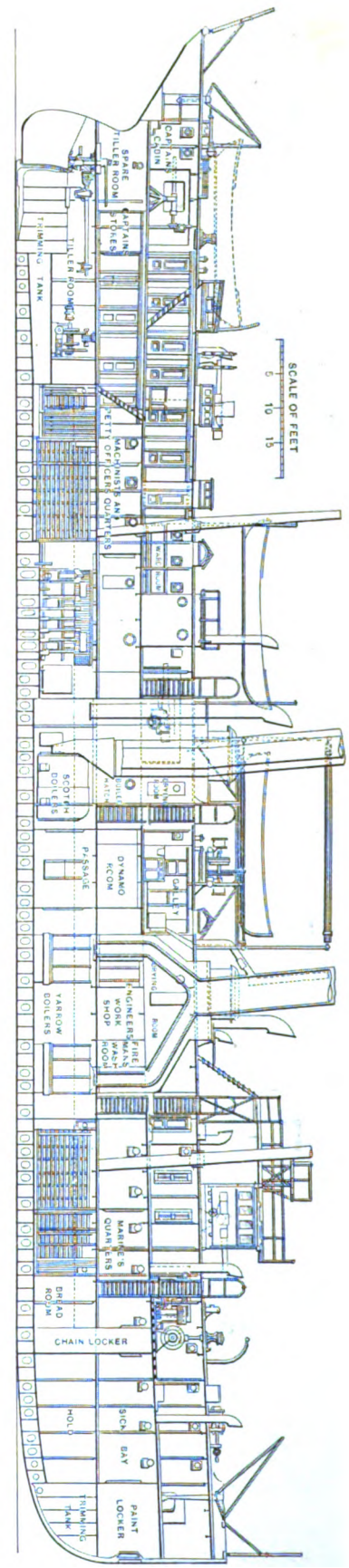
are cast hollow for water circulation. The connecting rods are oil-tempered, forged steel, finished all over, 40 in. between centers, turned 3 3-4 in. at the big end and 3 in. at the neck, with a 1 1-2 in. hole bored through lengthwise. They are secured to the crank pin brasses by 2 in. bolts. Composition distance pieces are fitted between the butt and crown brasses and are removable without taking out the cap bolts. The crank shafts are in three sections, the forward and after sections having each one crank and the middle section two cranks. They are 15 ft. long by 6 1-4 dia. and are bored axially with a 3 1-4 in. hole. The pins are 6 3-4 in. dia. and 7 1-2 in long, with a 3 1-2 in. axial hole. The webs are 7 1-4 in. wide and vary in thickness, thus: H. P. 4 in., 1st I. P. 3 3-4 in., 2d I. P. 3 1-2 in., H. P. 3 1-4 in. The ends are chamfered. Coupling disks are 13 in. dia. and 1 5-8 in. thick, each held together by six 1 5-8-in. forged steel bolts. Valve gear is of the Stephenson, double-bar link pattern, the 1st I. P. valve stems being carried by a crosshead. The eccentrics are cast iron with an eccentricity of 2 in. The backing eccentrics are keyed on the shaft and the go-ahead eccentrics fastened to them by through bolts. The H.P. and 1st I.P. eccentrics have a 2 in. face and the 2d I.P. and L.P. have a 2 3-4 in. face. The straps are composition, finished all over, and lined with white metal. Forged steel is used for the rods, the distance from center of eccentrics to center of link pins being 3 ft. 7 1-4 in. The main links, link blocks, and suspension links are all of forged steel also. Eccentric rod pins are forged on the main links, 11 in. between centers. Composition, lined with white metal, is used for crank shaft bearings. These are turned cylindrical, so that the bottom brasses can be slipped out without taking out the crank shaft. The cap bolts are 1 5-8 in. dia. The reversing shaft for each engine is forged steel, and the link arms are made with a slot fitted with a cast steel block, adjustable by a screw and hand wheel, permitting a variation of cut-off, from about 0.5 to 0.7 of the stroke. The reversing gear consists of a steam cylinder and a hydraulic controlling cylinder acting directly on an arm fixed on the reversing shaft. The working levers are on the inboard side of each engine between the H.P. and I.P. cylinders. An elaborate system of lubrication is provided. Each engine is fitted with a 5-gallon tank overhead connected to lubricators on the engine by 1-2 in. pipe. There is also an additional tank from which oil can be run into the crank shaft bearings under a head, if necessary. A sight feed oil cup is attached to each steam main at the H.P. valve chest, and globe cups are fitted to the piston and balance valves. Water pipes are also fitted to all moving parts.

The exhaust passages from the H.P. steam chest to the 1st I.P. steam chest and from the latter to the 2d I.P. are cast in the cylinder casings. From the 2d I.P. to the L.P. steam chest two



LONGITUDINAL SECTION U.S. TWIN-SCREW GUNBOAT NASHVILLE.

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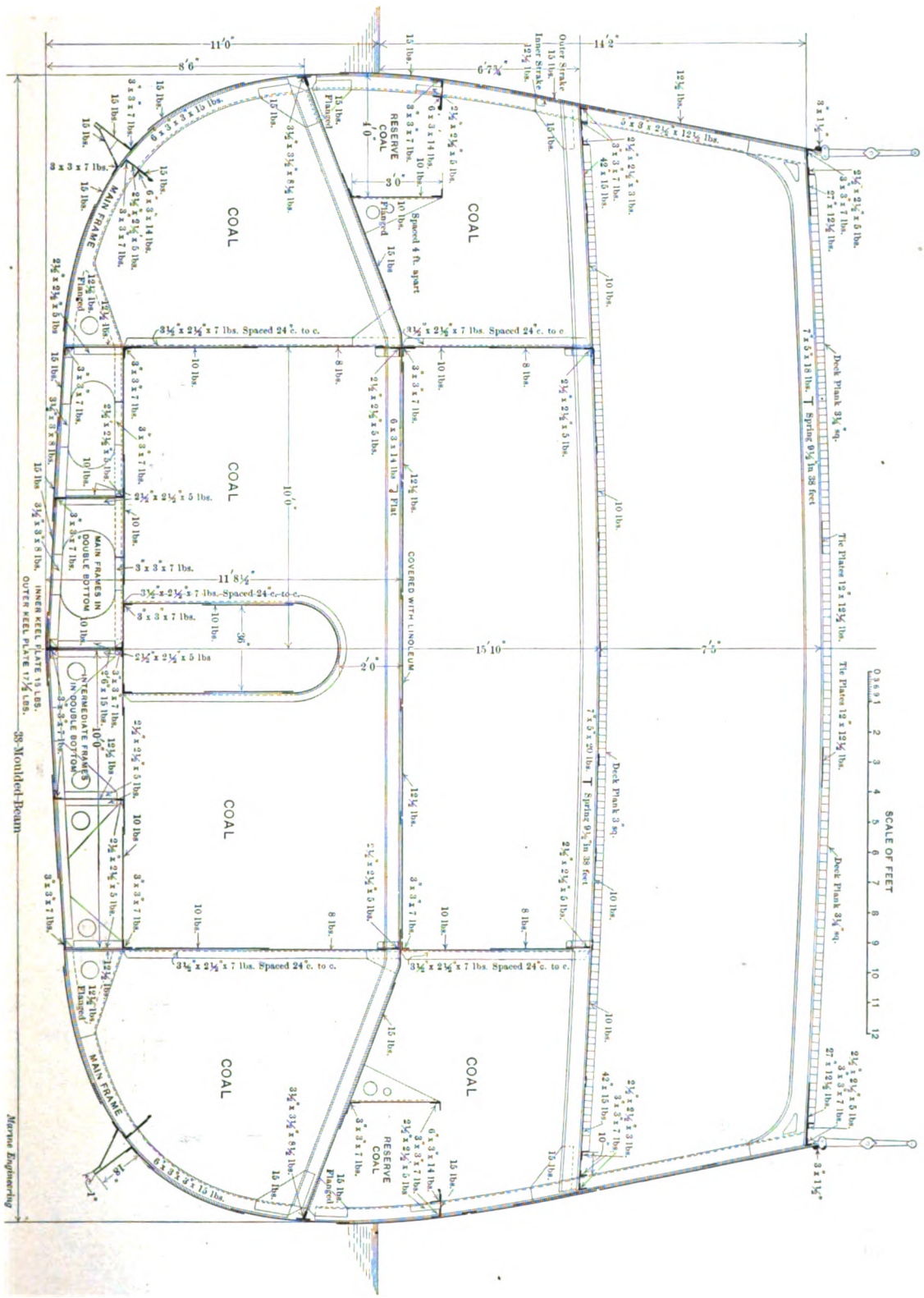

MIDSHIP SECTION U. S. TWIN-SCREW GUNBOAT NASHVILLE.

BUILT BY NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO.

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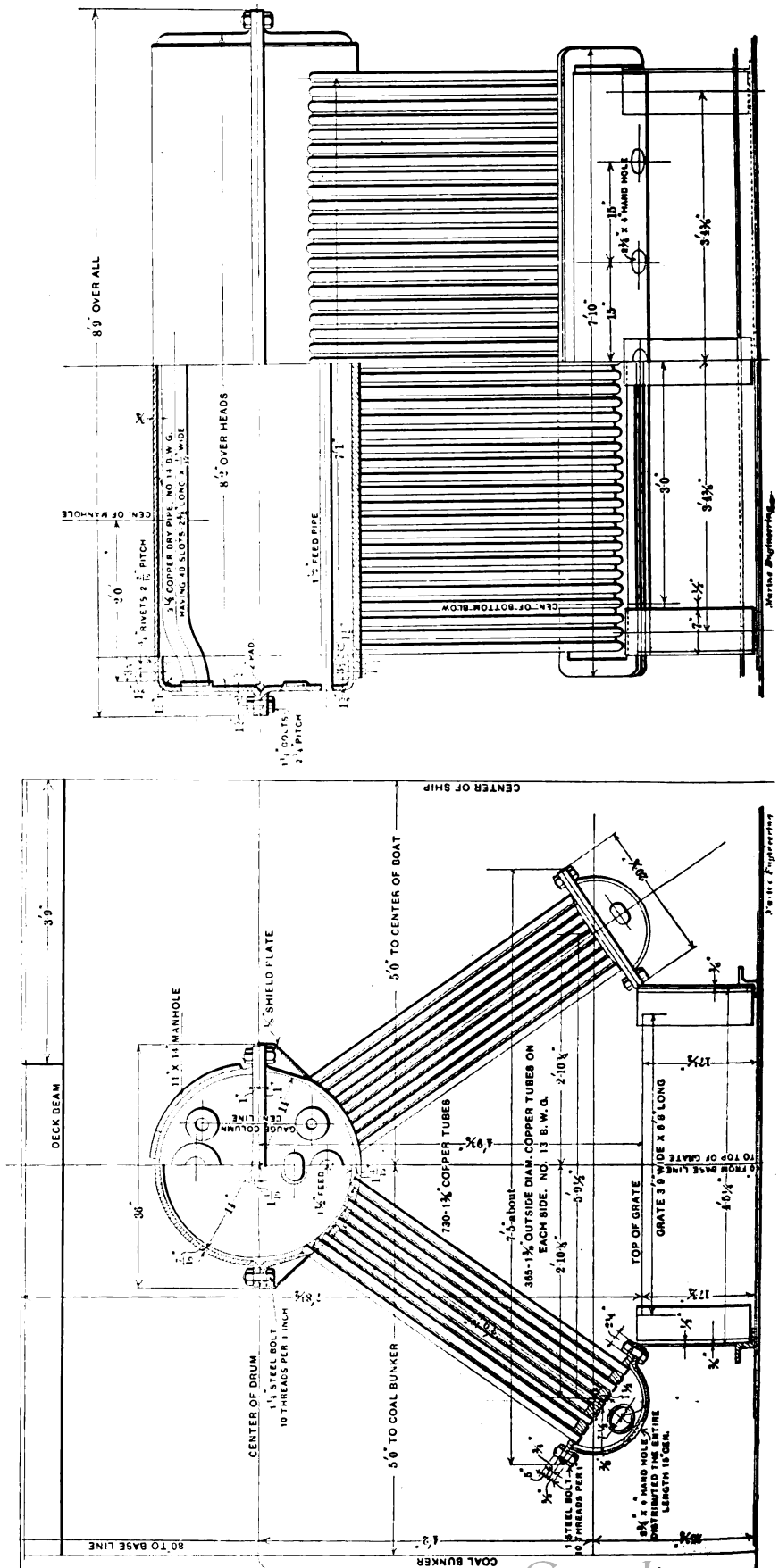
copper pipes, one on each side, carry the exhaust. That in the inboard side is 7 in. inside and is fitted with a straight way valve, which is shut when running triple expansion. On the outboard side the exhaust pipe connects with both the L.P. steam chest and the condenser. The branch to the condenser is 7 1-2 in. dia. The live steam pipe from the Yarrow boilers is 6 1-2 in. bore, reduced to 5 in. in the branches at the engines which connect with the throttle valve. The branches from the two auxiliary boilers are 4 in. bore feeding a 5 in. main reduced to 3 1-2 in. in the branches which connect with the 1st I.P. valve chests. Each engine has a double poppet throttle valve 4 in. dia. bolted to the high-pressure cylinder casing.

To run triple expansion the disconnecting coupling between the 2d I.P. and L.P. cranks is uncoupled, the exhaust from the 2d I.P. to the L.P. valve chests shut off and the valve between the 2d I.P. and condenser opened. The Yarrow boilers are shut down, as is also the valve on the 5 n. steam main of the auxiliary boilers leading from the boiler room to the engines. The stop valves on the auxiliary boilers are then opened and the live steam flows from the branch pipes of the two Scotch boilers to the T which leads out to the engine room. A junction is made with this T by the main from the water-tube boilers, between the single 5 in. main leading to the engines and the branches to the Scotch boilers. Close to this junction is the check valve before referred to. The steam from the Scotch boilers meets with no resistance here


8'9" OVER ALL
8'9" OVER HEADS
CEN. OF MANHOLE
CEN. OF BOTTOM BLOW
1½" FEED PIPE
CENTER OF SHIP
5'0" TO CENTER OF BOAT
DECK BEAM
SHIELD PLATE
11" X 14" MANHOLE
CARGO COLUMN CEN. LINE
730-1¾" COPPER TUBES
365-1¾" OUTSIDE DIAM. COPPER TUBES ON EACH SIDE. NO. 13 B. W. G.
TOP OF GRATE
GRATE 3'0" WIDE X 6'0" LONG
CENTER OF DRUM
1¼" STEEL BOLT 10 THREADS PER 1 INCH
5'0" TO COAL BUNKER
80" TO BASE LINE
COAL BUNKER

YARROW WATER-TUBE BOILERS U.S. TWIN-SCREW GUNBOAT NASHVILLE.

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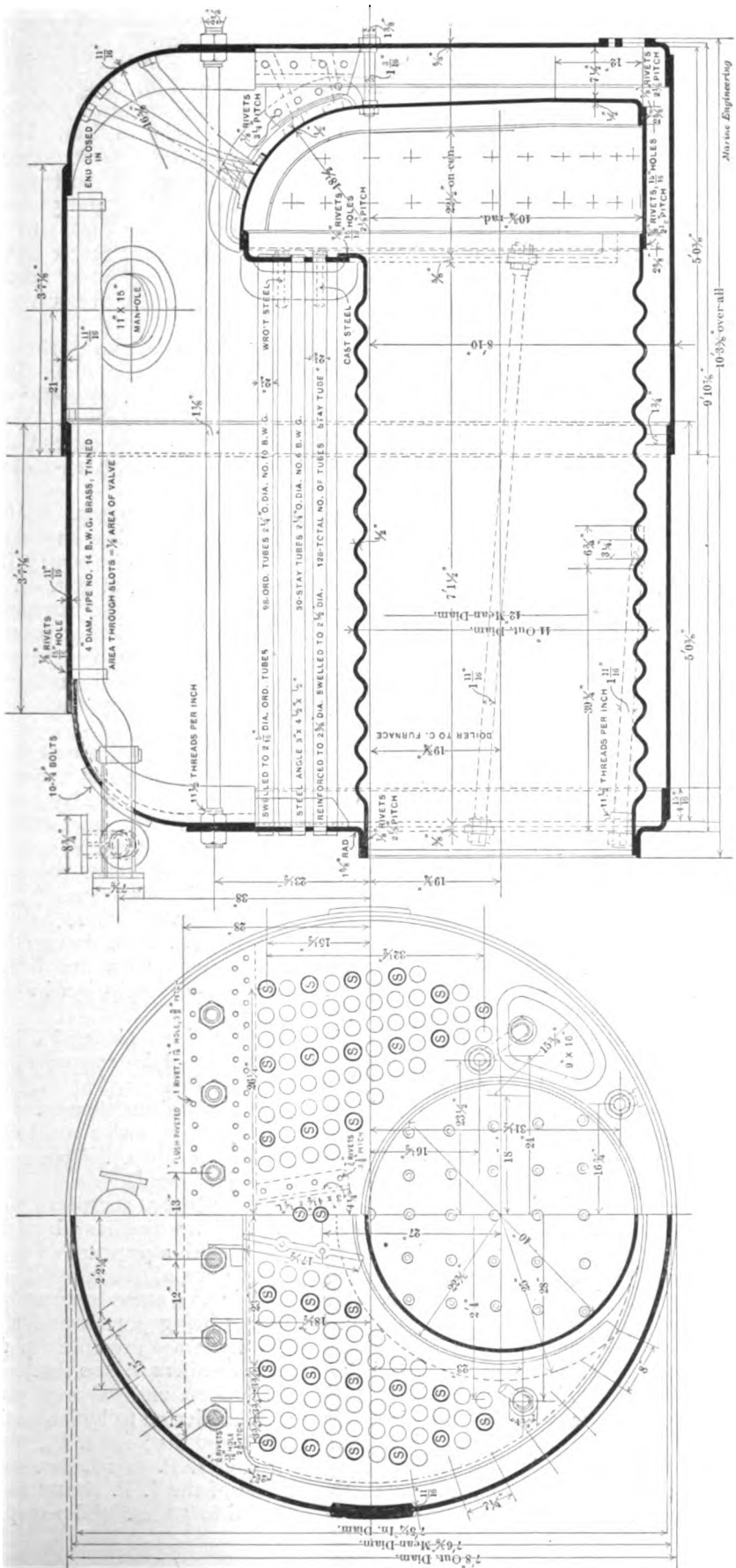
Marine Engineering
END CLOSED IN
11" X 15" MAN-HOLE
4" DIAM. PIPE NO. 14 B.W.G. BRASS, TINNED
AREA THROUGH SLOTS = ¾ AREA OF VALVE
10-¾" BOLTS
BOILER TO C. FURNACE
CAST STEEL
WRO'T STEEL
STEEL ANGLE 3"X 4"X ½"
REINFORCED TO 2⅝ DIA. SWELLED TO 2¾ DIA.
128-TOTAL NO. OF TUBES
STAY TUBE
30-STAY TUBES 2¾"O. DIA. NO. 6 B.W.G.
55-ORD. TUBES 2¾"O. DIA. NO. 10 B.W.G.
SWELLED TO 2½ DIA. ORD. TUBES
11½ THREADS PER INCH
39¾" Out. Diam.
12 Mean Diam.
11" Out. Diam.
7'8" Out. Diam.
7'6¾" Mean Diam.
7'5¾" In. Diam.

SINGLE-FURNACE RETURN-TUBE BOILERS U.S. TWIN-SCREW GUNBOAT NASHVILLE.

when the Yarrow boilers are shut down, and consequently it lifts the check and flows into the 6 1-2 in. main which leads to the H.P. valve chests.

The thrust shafts are 12 ft. 6 in. long, 5 7-8 in. dia. bored with a 2 7-8 in. axial hole. Each has 9 collars 8 7-8 in. dia. and 1 1-8 in. thick. The bearings are fitted with the usual oil and water cooling arrangements. The propeller shafting for each engine is 46 ft. 2 in. over all, 6 1-8 in. dia. and bored with a 3 in. axial hole.

The propellers are manganese bronze, three-bladed, 6 ft. 8 in. dia., 7 ft. pitch, a true screw. The starboard propeller is right and the port left handed.

The condensers which are fitted outboard are cylindrical, with composition shells and seamless drawn brass tubes. The dimensions are: Dia. of condenser 3 ft., length between tube sheets 8 ft. The number of tubes is 946, giving a cooling surface of 1,238 sq. ft. and for both a ratio of cooling surface to total heating surface of 1 to 2.16. Each propelling engine is fitted with an air pump, 14 3-4 in. dia., secured to the back frame and worked by arms and a rock shaft from the 2d I.P. crosshead. Centrifugal pumps are used for circulation, with 22 in. fliers, 7 in. suction and 6 in. discharge pipes, each driven by a single vertical engine 6 in. by 5 in. An auxiliary air pump is driven by each of these engines by arms from the crosshead. These pumps are 6 in. dia., with 4 in. stroke and suction pipes 2 3-4 in. dia. and delivery 2 1-2 in. dia. The delivery pipe discharges into the delivery pipe for the main air pump and the suction pipe is fitted with

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a branch for discharge from the evaporator trap. No auxiliary condenser is fitted, the auxiliaries exhausting into a main condenser, or into the 1st I. P. valve chest as desired. There is a very complete installation of auxiliaries, including a number of Blake vertical duplex pumps with composition water ends. The main feed pumps have 7 in. steam and 4 in. water ends with 7 in. stroke. There is also a fire and bilge pump, with steam cylinder 7 1-2 in. and water cylinder 4 1-2 in by 8 in. stroke, also bilge and sanitary pump with steam cylinder 6 in. dia. and 7 in. stroke, and water cylinder 4 in. dia., and a distiller pump with steam cylinder 6 in. dia. and water cylinder 4 in. dia. and 7 in. stroke. The distilling apparatus includes a Baird evaporator and two double-coil Baird distillers, and a combined fresh and salt water pump, with 3 1-2 in. steam cylinder and 2 1-8 in. water ends by 4 in. stroke. In each fire room there is an auxiliary feed pump.

The weight of both main engines complete is slightly in excess of 28 1-2 tons.

There are four main boilers of the Yarrow type, located in the forward fireroom. Drawings of these published herewith show the details of design. They are fitted in a fore and aft position, one on each side of the keel line; facing in a common fire room athwartship. Each boiler occupies a space 8 ft. 9 in. long, 7 ft. 5 in. wide, and 7 ft. 6 in. high, and weighs with fittings about 6 1-2 tons. The weight of water in each is approximately 1 1-3 tons. The grates are 3 ft. 9 in. wide by 6 ft. 8 in. long. Each boiler has 730 1 3-8 in. O. D. Copper tubes, 13 B. W. G. thick. The grate surface is 25 sq. ft., and heating surface 1,000 sq. ft., a ratio of heating surface to grate surface of 40. All of the material subject to pressure, except the tubes, is open hearth steel. The edges of the water and steam drum sections are planed true and grooved and joined with red lead. The tubes are spaced zig zag, in 9 in. rows 2 1-8 in. centers longitudinally, and 1 7-8 in. diagonally. Each boiler is fitted with a Thornycroft automatic feed regulator.

The auxiliary boilers are two single-ended, single-furnace, Scotch boilers, 9 ft. 10 7-8 in. long by 7 ft. 6 5-8 in. dia. Dimensioned drawings of these boilers are also here given. Each is fitted with one corrugated flue, 40 in. dia., with grate 6 ft. long, and has 98 ordinary tubes of 10 B. W. G. and 30 stay tubes of 6 B. W. G. The heating surface for each is: Tubes, 544.27 sq. ft.; furnace, 47 sq. ft.; combustion chamber, 83.74 sq. ft.; a total of 675.01 sq. ft. The grate surface is 21 sq. ft., giving a ratio of grate surface to heating surface of 32.14. Each boiler weighs with fittings about 11 1-4 tons, and contains about 5 1-2 tons of water. Open hearth steel is used for the plates, and Clapp Griffith for the rivets.

The specifications for plates called for steel containing not more than .035 of 1 per cent of prosphorus and not more than .04 of 1 per cent of sulphur. Transverse specimens of shell plates were required to show a tensile strength of between 58,000 and 67,000 lbs., and an elongation of not less than 22 per cent in 8 in. Longitudinal specimens of the same tensile strength had an elongation of at least 25 per cent in 8 in. The elastic limit was required to be at least 29,000 lbs. For furnace and flange plates the tensile strength required was between 50,000 and 58,000 lbs., and an elongation of 26 per cent, either longitudinally or transversely. Very severe tests were also applied to the rivets, and all boiler tubes were required to stand a hydrostatic pressure of at least 500 lbs.

The boilers were built of two courses of sheets each with curved top sections. The shells are 11-16 in. thick; back plates, 5-8 in., combustion chamber 1-2 in. and furnaces 1-2 in. thick. The inner butt straps are 9-16 in. thick, and outer butt straps 5-8 in. thick, treble riveted with 13-16 in. rivets.

There are two smoke pipes, with tops 80 ft. above the grates. For the main boilers the pipe is 5 ft. dia., and for the auxiliary boilers 3 ft. dia., both finished to an outside dia. of 5 ft. 6 in. They are fitted with ladders on the forward sides. Ash hoists are fitted in each boiler room, and a See ash ejector in the forward fire room. Water for the ejector is supplied with an auxiliary pump, of which there are two, one in each fire room.

Forced draft is provided by three Sturtevant blowers. There are two 36 in. blowers in the forward fire room, with double engines 3 1-2 by 2 1-2 in., with cranks set opposite; and one 48 in. blower in the after fire room with cylinders 4 in. by 3 in. Each blower takes air from the fire room, which insures a good down draught of fresh air, and delivers it to ducts leading to the ash pits. There are also seven fans, driven by electric motors at various points on the berth deck and below, to secure good ventilation in the living quarters.

The electric plant consists of two General Electric direct connected sets, supplying current on the lighting circuits to 240 incandescent lamps, one search light and the usual signal lamps.

There are sixteen coal bunkers with a total capacity of 400 tons, sufficient for a distance of about 7,000 miles at cruising speed.

Severe tests were imposed before acceptance of the finished machinery. The auxiliary boilers were filled full and heated until a pressure of 250 lbs. was reached, and the main boilers and all connections were tested in the same manner to 360 lbs. per sq. in. After being put aboard the main boilers were tested by steam pressure up to 300 lbs., and the auxiliary boilers to 200 lbs. per sq. in. The cylinders, jackets and valve chests of the main engines were subjected to hydrostatic tests, as follows: H. P., 360 lbs.; 1st I. P., 225 lbs.; 2d I. P., 150 lbs., and I. P. to 100 lbs. per sq. in. The exhaust side of the I. P. chests and the condensers were tested to 30 lbs. All pumps,

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valve boxes and all fittings of feed pumps were tested to 450 lbs., and fire and bilge pumps to 300 lbs. per sq. in.

Plans for the hull were drawn by the Bureau of Construction and Repair, under the supervision of Chief Constructor Philip Hichborn, U. S. N., and for the machinery under the supervision of Commodore George W. Melville, U. S. N., Chief of Bureau of Steam Engineering.

The contract trial over a 30 knot course off the New England coast was conducted by Passed Assistant Engineers W. Strother Smith and C. B. Price, U. S. N., whose report of the trial is here reproduced from the Journal of the American Society of Naval Engineers.

Trial Trip Data.

The trial passed off without a hitch of any kind, the engines were remarkably free from vibration, the bearings were cool without the use of water on them, the boilers steamed steadily, the Yarrow boilers carrying steam almost as steadily as the Scotch type. Live steam was frequently admitted from the main steam pipe into the first receiver, and at times live steam was admitted also into the second receiver. The coal used was Nuttalberg, put up in bags of 112 pounds net.

The trial crew numbered 83 officers and men, including pilots and draftsmen. The engine room force, 44 in number, was directed by Chief Engineer John A. Williams, connected with the Newport News Co., and was divided as follows: chief engineers, 2; engineers, 2; machinists (special), 4; oilers, 12; boiler makers, 2; water tenders, 3; firemen, 8; coal passers, 4; boys, 4; yeoman, 1, and storekeepers, 2. The water tenders and oilers were machinists who had worked on the erection of the machinery.

Draught of water, beginning of trial, forward, ft. and in.	9-10½
beginning of trial, aft, ft. and in.	12- 2
end of trial, forward, ft. and in.	9- 9
end of trial, aft, ft. and in.	12- 0
mean, forward, ft and in.	9- 9¾
mean aft, ft. and in	12- 1
average on trial, ft. and in.	10-11⅜
Displacement (mean), tons	1,364
Area of immersed midship section	370
Wetted surface, square feet	8,881
Speed, mean, knots	16.299
Slip (mean of both screws) per cent	23.5
Speed³ × area immersed midship section ÷ I.H.P. (*A*)	640.4
Speed³ × displacement⅔ ÷ I.H.P. (*A*)	212.84
I. H. P. (*A*) per 100 sq. ft. wetted surface	28.17

SYNOPSIS OF STEAM LOG.

	Starboard.	*Port.*
Revolutions of main engine, per minute	308.53	308.3
Piston speed, ft. per minute	925.59	924.9
Steam pressure, in boilers, per gauge Yarrow,	252	aux., 154
at engine, per gauge	249	249
1st receiver, absolute	146	144
2d receiver, absolute	72	73
3d receiver, absolute	28	28
Vacuum in condenser, inches	25	25
Throttle valve opening	wide.	wide.
Double strokes of circulating pump, per minute	354	332
Double strokes of feed pump, per min., main	28.5	aux., 29.5
Temperature in degrees Fahrenheit:		
Engine room	103	103
Injection	52	52
Discharge	116	112
Feed, in tank	136	136
Fire rooms	131	105
Air pressure in ducts, mean, inches of water.	1.26	
Revolutions of forced draft blowers, average, per minute	662	
Mean pressure in cylinders, H.P.	71.95	77 18
1st I.P.	45.38	45.57
2d I.P.	26.82	26.87
L.P.	17.50	17.47

	Starboard.	*Port.*
Aggregate equivalent pressure referred to L.P. piston	49.74	50.33
I. H. P.:		
H.P. cylinder	184.7	197.88
1st I. P. cylinder	275.23	288.64
2d I.P. cylinder	337.59	338.13
L.P. cylinder	444.11	422.14
Collective, main engine	1,241.60	1,246.79
Circulating pump	7.03	7.03
Three feed pumps	21.74	
Three forced draft blowers	9.54	
Other auxiliaries	2.12	
Collective, main engine and circulating pumps (*A*)	2,502.45	
Total all machinery in use	2,535.85	
Indicated thrust (main engine only), lbs	18,971	19,065
Indicated thrust per sq. ft. of developed blade area, lbs	1,457.07	1,464.28
Indicated thrust per sq. in. of thrust bearing.	6.06	6.09
Cubic ft. swept per minute by L. P. piston per I.H.P.	4.68	4.66
Sq. ft. cooling surface per I.H.P. (*A*)	.99	
Sq. ft. of H.S. per total I.H.P.	2.11	
I.H.P. per sq. ft. grate surface, total	17.86	
heating surface, total	.474	
ton machinery (penalty weight)	15.37	

Coal.—Kind and quality, Nuttalberg, hand-picked and bagged. Pounds per hour, 7,593; auxiliary boilers, 1,940, Yarrow, 5,653.

On the run from Newport News to Bridgeport, a trial was conducted by Passed Assistant Engineer W. Strother Smith, U. S. Navy, with the engines working triple expansion and the two Scotch boilers under forced draft. The following results were obtained:

Distance run during trial, nautical miles			51
Elapsed time, hours, minutes, seconds			4:33:16
Average speed, knots			11.199
Slip, per cent			10.24
Wind, points from ahead			16
force, navy standard			4 to 6
Steam pressure, average			114.6
		Starboard.	*Port.*
Revolutions, average		180.7	181.52
I.H.P., main engines	H.P.	66.61	67.36
	I.P.	49.21	49.15
	L.P.	93.41	95.12
total		209.23	211.63
collective, both engines		420.86	
all machinery in operation		448.61	
Coal per I.H.P., per hour		2.84	
consumed per hour, lbs		1,273.3	
Equivalent consumption, tons per day		13.687	

On this run the coal used was New River steam coal.

The Hon. Theo. Roosevelt, Assistant Secretary of the Navy, delivered a patriotic address at the formal opening of the Naval War College, at Newport, R. I., June 1, in the course of which he said:

"This nation cannot stand still if it is to retain its self-respect, and to keep undimmed the honorable traditions inherited from the men who with the sword founded it and by the sword preserved it. We ask that the work of upbuilding the navy and of putting the United States where it should be put among maritime powers go forward without a break. We ask this not in the interest of war, but in the interest of peace. No nation should ever wage war wantonly, but no nation should ever avoid it at the cost of the loss of national honor. A nation should never fight unless forced to; but it should always be ready to fight. The mere fact that it is ready will generally spare it the necessity of fighting. If this country now had a fleet of twenty battle ships their existence would make it all the more likely that we should not have war."

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METHOD OF SECURING AN AUTOGRAPHIC RECORD OF STEAMSHIP VIBRATIONS.

BY PROF. W. F. DURAND.

The purpose of a vibration recorder, the use of which in recording the vibrations of ships has been illustrated in the June issue of this journal, is obviously to record in some autographic manner, relative to the earth or to the mean position of the ship as a whole, the vibratory motion of the ship at the point of application. At any instant a given portion of the ship is necessarily moving simply in one direction. This direction, however, will continually change so that the motion as a whole may become very complex. In all instruments for recording such movements it is therefore customary to analyze the motion into two or three components at right angles to each other. Thus a part of the ship may be describing a more or less irregular oval path situated in a transverse plane, or not even restricted to any one plane. The only manner in which such a motion can be autographically recorded in such way as to show its relation to time is by means of a decomposition into components (1) vertical and (2) horizontal transverse if the motion is in one plane, or (1) vertical (2) horizontal transverse and (3) horizontal longitudinal if it is not restricted to one plane. The vertical component thus shows simply the vertical part of the motion relative to time, or as we may term it, the time history of the vertical part of the motion as a whole. Similarly, the other components give time histories of the other parts of the motion. From such components the motion as a whole may be reconstructed if desired, though this is usually not necessary, as the investigation of the motion and its various characteristics may usually be more advantageously studied from the components, as recorded, than from such a reconstruction of the complete movement.

Taking now the horizontal component for example, we note that its chief characteristic is its more or less irregularly recurrent nature. The maximum displacement goes from extreme right to extreme left and to extreme right again, in general once for each revolution of the engine. This part constitutes the fundamental period or cycle. Within this cycle the history may be either smooth or irregular, as may be seen from numerous examples of vertical vibrations in the curves above referred to.

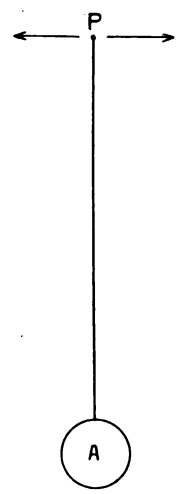

FIG. 1.

Now, in order to effect the autographic record of a horizontal vibratory motion of this character, a well known principle of mechanics is made use of. This may be illustrated in Fig. 1. P A represents a simple pendulum with weight A supported at P. Now, suppose that the natural period of vibration of this pendulum is 1 sec. and suppose the point P to receive a small horizontal vibratory motion in direction as indicated by the arrows. If such disturbances are timed so as to correspond with the natural period of the pendulum, or one per second, the weight A will gradually acquire a large oscillation far exceeding in amplitude that of the displacement applied. The same phenomenon is familiarly illustrated by the impact of the feet in walking on a bridge where the natural period of vibration of the latter corresponds to the period of the step. A comparatively trivial impact may in such cases give rise to an extremely violent oscillation. If, on the other hand, the disturbances applied at P (Fig. 1) are very much more rapid than the natural period of oscillation, it can be shown mathematically, and results experimentally, that the weight A suffers no appreciable displacement. In such a case the point P and the supporting frame really vibrate about A, which for the time remains practically at rest. Suppose next that we attach to A a marking pen, and to the frame work supporting P a strip of paper moved by clockwork steadily upward relative to the frame. The paper would then oscillate relative to A, and as it moved upward, there would by the combination of motions be traced upon it a curve showing the time history of the horizontal motion of the frame relative to A, or, vice versa, of A relative to the frame. The point to be borne in mind is that in the instrument as ideally constructed for the utilization of this principle the ship and with it the frame of the instrument and the paper itself must all be considered as vibrating relative to the weight A, the latter being the point really at rest so far as the vibratory motion is concerned. In the actual instrument it may be more convenient to attach the marking pen at some point other than A, in the line A P, or its extension. This may be done in order to magnify for record the actual motion of the frame relative to the point A, and is thus merely a geometrical device not otherwise affecting the theory or operation of the instrument. In the actual construction, however, it is not convenient or necessary to carry out these principles to the ideal extent indicated above. The reasons for this departure will be briefly referred to at a later point.

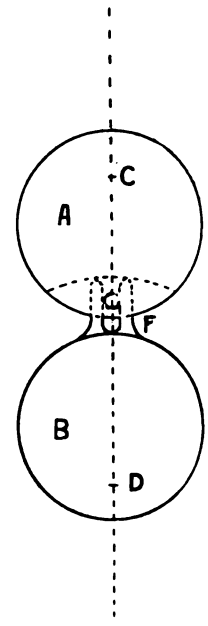

FIG. 2.

It thus appears that the fundamental requirement is a form of pendulum in which the period is somewhat longer than that of the vibration to be recorded. Now on board ship the period of the principal vibration will be that of the engines.

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which may be taken usually at from 60 revolutions per min. upward. It follows that the pendulum should be such that the period for a double swing should be less than 1 sec., and that of the period as usually stated should be less than 1-2 sec. If a simple pendulum such as P A were to be employed its length would in such case be necessarily greater than 9 in. It is well known, however, that compound pendulums, or vibrating systems, may be arranged in which the time of vibration is much increased without an undue extension of the dimensions. That made use of in the instrument here described is shown in Fig. 2. A and B are cylinders with axes horizontal pivotted at C and D. A fork F

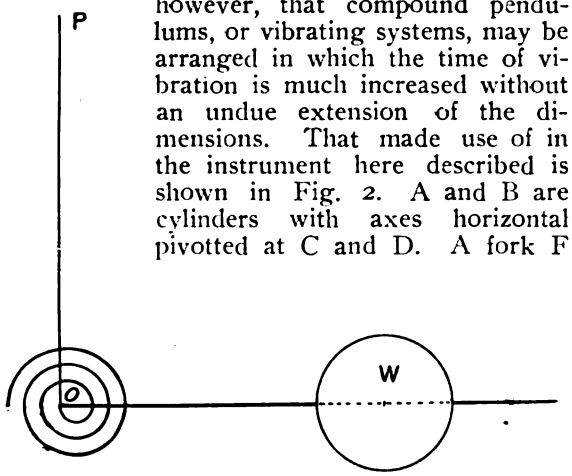

FIG. 3.

attached to B reaches up and engages with a pin attached to A as shown. Now, in order that such a system may oscillate due to the force of gravity, the proportions must be such that a slight lateral disturbance shall involve a rise in the center of gravity of the system as a whole, and, other things being equal, the less such rise the less the return force and the longer the period. Now it is readily seen that such a disturbance will tend to raise the center of gravity of A and to lower that of B. Hence by a proper proportion and arrangement of parts the resultant elevation of the center of gravity may be made as small and the period as long as may be desired. The practical limit arises from the fact that, with a very small return force, the less able is the system to overcome such resistances as friction in the pivots and joints, and between the recording pen and the paper. Hence a compromise is necessary, and for such purposes as we are now considering and with such a vibrating system, a period of 1-2 sec. is not unsuitable, though one of greater length might be preferable. The shorter period is moreover the more permissible from the fact that the slight friction of the system, while not sufficient to disturb the action of the instrument for the purpose desired, is yet enough to exert a restraining influence on cumulative vibration, and also on an irregular continuance of the oscillation after the disturbing impulse has changed its character.

The form which this construction takes is shown in Fig. 4. The tracing pen is attached to B (Fig. 2), and reaches upward some little distance so that the record magnifies the actual motion about two and one-half times.

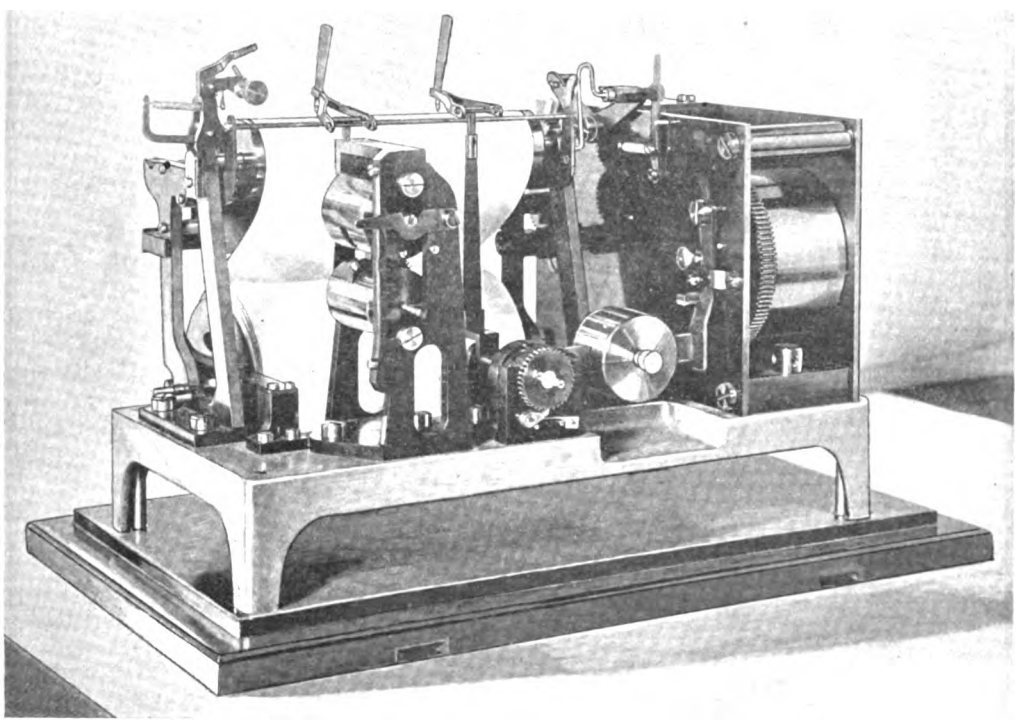

FIG. 4.—INSTRUMENT FOR AUTOMATICALLY RECORDING VIBRATIONS.

Turning now to the vertical component, we find a somewhat different disposition necessary. The

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displacement is here vertical, and we cannot make use of the ordinary pendulum, as in such case the disturbance would give rise to no return force. Among other means, however, the necessary force may be provided by a coiled spring connected with a horizontal arm and weight, as illustrated in Fig. 3. The tension of the spring may be adjusted, as well as the location of the weight, on the arm, so that for any given position of the latter the spring can be made to furnish the necessary support with the arm horizontal. It is then evident that if in such condition the weight be displaced vertically in either direction, the spring will exert a return force, and the combination will oscillate at a rate depending on the proportions of the system. By choosing these properly any desired period within limits may be obtained. Practically it may be taken about the same as for the horizontal system. Now, in the same manner as in the preceding case, if with such a system the point O be subjected to a periodic vertical disturbance of higher period than the natural rate of the system, the weight W will remain practically undisturbed and the point O and supporting frame work will oscillate about it. The vertical motion is then, by means of the arm O P transferred into the horizontal direction, magnified and recorded by a pen at P on the paper strip, in the same manner as for the other component. The manner in which these principles are carried out may be seen from the construction shown in Fig. 4.

The strip of paper is drawn by clockwork from one roll to another under the pens in the manner common in instruments of this character. A fan with adjustable vanes is provided for controlling the speed, and once the corresponding speed attained, it remains practically constant. A pencil is provided, as shown on the top of the instrument to the left, for marking, if desired, the strip of paper at equal time intervals as determined from a watch held in the hand of the observer. If desired, such pencil might be placed under the control of a magnet energized by a current controlled by a clock marking seconds. Usually, however, the time record is of secondary importance, as the known revolutions of the engine suffice to determine the fundamental periodicity of the record.

For the interpretation of the record, a calibration or comparison of a disturbance of known periodicity and amplitude with its record on the instrument is desirable. With a series of such comparisons at different rates of vibration, it becomes a simple matter to interpret any given record as to the amplitude of the actual vibration, and as to its distinguishing characteristics.

With the instrument shown in Fig. 4, two components, one vertical and one horizontal, may be simultaneously recorded. For the latter, of course, the instrument must be so placed that the plane of vibration of the pendulum is in the direction of the component desired.

The instrument, was designed by Prof. Milne, of the Imperial University of Tokio.

DANISH STEAM RAILWAY FERRIES AND ICE-BREAKING STEAMERS.*

BY CAPTAIN I. C. TUXEN, ROYAL DANISH NAVY.

Denmark, besides the Peninsula of Jutland, consists of a great number of islands, separated from one another by sounds or belts. Most of these waters are shallow, at least near the harbors; only the larger of them may at times be rough. During the winter they are often filled with ice for one or more months; in some cases the ice covers the whole surface, but in other cases the ice is drifting. Across these waters there is a considerable traffic, and great efforts have been made by the State and private firms to continue this traffic uninterruptedly during the whole year. The State railways have provided a floating material, consisting of steam railway ferries and ice-breaking steamers specially adapted for the purpose.

Steam Railway Ferries.

Formerly the traffic was carried across the water in ordinary paddle steamers, but the trouble of transhipment of the goods at each crossing led to the construction of steam ferries. The first steam railway ferry was a paddle steamer, built in 1872 in Newcastle, capable of carrying five freight cars on a single line of rails. The next ferry—similar to the first—was built in 1877. Four larger ferries were built in 1883, and the development has continued, so that the State railways now possess fifteen steam ferries, besides one building.

Table I annexed gives the principal data of these ferries.

Ten of the ferries have a single line of rails, but the five largest have double lines. Twelve of the ferries have paddle wheels, and only three have screw propellers. Two of the latter, fitted with twin screws, are running across a narrow channel, and can work better through ice than paddle steamers could do. The single-screw ferry is really an ice-breaking ferry, and will be described further on.

Detailed description of the ferries is unnecessary, as they are much like ordinary passenger steamers and ferries. Some special features of the class may be mentioned, and a short description of one of the largest ferries will suffice. The first ferries were constructed to take freight cars only, and thus to avoid the transhipments of goods. This principle has been followed throughout the development. Passenger coaches, as a rule, are not taken on board. In some cases a few through coaches are taken, the bulk of the passengers leaving their coaches at the ferries. Comfortable saloons for passenger accommodation are fitted underneath the deck in all the ferries, being well heated and ventilated, and in the later ferries lighted by electricity.

All the ferries have heavy timber fenders round

* Read before the International Congress of Naval Architects and Marine Engineers, London, 1897.

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the outside from end to end, at the height of the deck. The shape of this fender at the ship's ends is exactly the same for all the ferries, so that they may all fit in the different ferry harbors belonging to the seven crossings at which railway ferries are used.

The piers of the ferry harbors are constructed of timber and shaped to the form of the ferry; this goes end on into the berth and is stopped by buffers. A hinged bridge is lowered to the end of the ferry, which is arranged to receive the bridge, over which the cars roll on board or ashore. As there are no great variations in the water level, such as occur in tidal harbors, the difficulties are much reduced.

The lines of rails pass through the whole length of the deck of the ferries, and the cars can be shipped or unshipped at either end, these being alike. The rails are placed directly on the plating of the deck and bolted to it. Underneath the deck beams heavy longitudinal girders are built, one for each rail in the small ferries, and one for each line of rails in the large ferries, to take the weight of the freight cars. The girders are again supported by a number of pillars. The paddle ferries have a rudder at each end, and steam practically as well astern as ahead; they vibrate, however, rather more when going astern.

The arrangements and installations are very similar in all the ferries, and a general idea of them may be had from the sectional drawing of the largest ferry, the Kjöbenhvn, (see supplement), built in 1895, which needs no further explanation. The engines of this vessel are compound, with the cylinders placed diagonally.

TABLE II.—DANISH ICE-BREAKING STEAMERS.

Name.	Built	Builder.	Single or twin screw.	Length between perpendiculars.	Breadth at water line.	Depth moulded.	Draught, forward, ordinary trim.	Draught, aft, ordinary trim.	Displacement.	Draught, aft, with tanks aft filled.	I.H.P. on four hours' full power trials.	Speed.	Cost of building.
				Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Tons.	Ft. In.		Knots.	
Staerkodder.	1883	Burmeister & Wain, Copenhagen	Twin	150 0	27 6	14 0	—	10 6	625	11 2	800	—	$122,500
Bryderen....	1884	Kockrun, Malmó	Single	131 0	31 8	15 2	11 7	13 0	—	—	—	—	114,500
Mjölner.....	1890	Elsinore Shipbuilding Co.	Single	135 0	32 8	15 7	10 9	12 9	728	16 0	1350	12.2	116,000
Thor.....	1890	Motala & Lindholm, Sweden.	Single	135 0	32 8	15 7	10 9	12 9	728	16 0	1350	12.2	112,750
Tyr.....	1894	Elsinore Shipbuilding Co.	Single	136 0	33 11	15 7	10 9	12 9	735	16 0	1350	12.2	112,750
Sleipner.	1896	Burmeister & Wain, Copenhagen	Single	161 5	39 0	18 6	12 9	17 9	1450	22 3	2600	12.75	166,500

TABLE I.—DANISH STEAM RAILWAY FERRIES.

Name.	Built.	Builder.	No. of lines of rails.	Paddle or screw steamer.	Length between perpendiculars.	Breadth, moulded.	Full power trial. Depth, moulded.	Draught, forward.	Draught, aft.	Displacement.	I.H.P.	Speed knots.	No. of cars to be carried.	Cost of building.
					Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	Tons				
Lille Belt.....	1872	Wigham Richardson and Co., Newcastle	Single	Paddle	140 0	26 0	—	7 3	7 3	—	340	8·0	5	$49,500
Fredericia.....	1877	Schichau, Elbing.....	Single	Paddle	140 0	26 0	—	7 8	7 3	—	360	8·0	5	47,000
Korsór.....	1883	Kockrun, Malmó.....	Double	Paddle	250 0	34 0	16 0	8 10	9 0	1220	1700	13·0	16	156,500
Nyborg.....	1883	Kockrun, Malmó.....	Double	Paddle	250 0	34 0	16 0	8 10	9 0	1220	1700	13·0	16	156,500
Hjalmar	1883	Schichau, Elbing.....	Single	Paddle	166 0	26 0	12 0	7 0	7 0	440	600	10·0	6	63,000
Ingeborg.	1883	Schichau, Elbing.....	Single	Paddle	166 0	26 0	12 0	7 0	7 0	440	600	10·0	6	63,000
Valdemar.....	1886	Burmeister & Wain, Copenhagen	Single	Twin screw	140 0	31 6	13 0	7 0	8 0	540	700	11·0	5	69,000
Sjalland.....	1887	Burmeister & Wain Copenhagen	Double	Paddle	274 0	34 0	16 0	9 2	9 2	1445	2055	13·4	16	197,000
Dagmar.....	1889	Burmeister & Wain, Copenhagen	Single	Paddle	166 0	26 0	12 6	7 9	7 9	495	470	10.2	6	73,500
Marie.....	1890	Burmeister & Wain, Copenhagen	Single	Twin screw	140 0	31 6	13 0	7 0	8 0	540	700	11·0	5	76,000
Krprs.-Louise ...	1891	Elsinore Shipbuilding Co.	Single	Paddle	166 0	26 0	12 6	7 11	7 11	570	710	11·0	6	85,500
Alexandra.....	1892	Burmeister & Wain, Copenhagen	Single	Paddle	177 0	26 0	12 9	7 10	7 11	582	634	10·8	6	86,500
Thyra.....	1893	Burmeister & Wain, Copenhagen.....	Single	Paddle	177 0	26 0	12 9	7 10	7 11	582	600	10·2	6	83,000
Jylland.....	1894	Burmeister & Wain, Copenhagen	Double	Single screw	171 0	36 0	19 2	10 9	12 2	1015	1210	12·2	10	135,500
Kjöbenhvn.....	1895	Burmeister & Wain, Copenhagen	Double	Paddle	274 0	34 0	16 6	8 10	9 1	1392	2155	14·4	18	207,500

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There are two high-pressure cylinders, 34 in. dia., and two low-pressure cylinders 62 in. dia.; the stroke is 54 in. There are four cylindrical boilers, with a steam pressure of 85 lb. per square inch. The ordinary full-power speed of the vessel at 9 ft. draught is 12.9 knots ahead or astern, with 1,400 indicated horse power. On the measured mile the vessel has, at the same draught, made 14.4 knots, with 2,155 indicated horse power.

Ice Breaking Steamers.

Formerly, when the sounds and belts were filled with ice, the traffic was carried across in open boats with huge bilge keels, on which the boats could slide on the ice. This was, however, a primitive way, and it was consequently found necessary to build ice-breaking steamers.

Table II gives particulars of the ice-breaking steamers now existing. The five first-named are used for carrying the traffic across the sounds and belts when the steam ferries cannot work on account of ice. The Bryderen belongs to a private company, the four others belonging to the State railways. The fifth, the Sleipner, is used for keeping open the free port of Copenhagen during ice winters, and to assist merchant vessels in getting through the Sound to or from the free port.

The first ice-breaker, the Staerkodder, did not quite answer the purpose. The reason for this was that she was intended to be a good passenger and cargo steamer at the same time as an ice-breaker, and that she was given a very small draught on account of the shallowness of the water where she nas to work. As seen from Table II, the length is large relatively to the breadth and draught, which has proved to be a drawback. Further, the vessel has twin screws, and these are too close to the water line, as the tanks aft are not large enough to put the vessel well down by the stern. Consequently the propellers are much exposed, and the blades often break off. At first the propeller blades were of gun-metal, but now they are of cast steel, which stands better against the ice. The engine power also proved to be insufficient for the work, the total indicated horse power being only 800. Experience gained with the Staerkodder was profited by in the construction of the next ice-breakers, and these have all proved to be very successful, both for working through water filled with drifting ice and through a thick layer of ice covering the water. Comparing the Staerkodder with some of the late ice-breakers—for instance, the Mjólner and Thor—it will be seen from Table II what alterations have been made to secure ice-breaking qualities. These vessels are made 15 ft. shorter, 5 ft. broader, and have 2 ft. 3 in. more draught. The draught can be much increased, as the water tanks aft are considerably larger, and the longitudinal stability smaller than in the Staerkodder. The later vessels have a single-screw propeller, and this can be brought well down underneath the water, and is thus better protected than the twin screws of the Staerkodder. The engine power has been much increased, being 1,350 indicated horse power on the full-power trial of two hours' duration.

A short description of the largest and newest ice-breaker, the Sleipner, of which a drawing is published in the supplement with this issue, will serve for all the class. The principal dimensions of the Sleipner are given in Table II. The hull is very strongly built, to be able to resist the enormous pressure of the ice. The frames are placed much closer together than usual, the frame space being 15 in. in the fore body, and 18 in. in the after body, while Lloyd's require 23 in. for a vessel of this size. The plating is further stiffened by six transverse watertight bulkheads, and five web frames in engine and boiler rooms. The outside plating is unusually thick, being 7-8 in. below the main deck in the fore body and 10-16 in. to 11-16 in. amidship and aft. This thickness is, on the average, 50 per cent greater than required by Lloyd's rules for a vessel of that size. The plating is worked flush-jointed, with internal butt and edge straps, to form a smooth surface, on which the ice can take no hold. The longitudinal ties inside the vessel—side keelsons and deck stringer plates—are also well strengthened, and carried through the whole length of the vessel. The shape of the bow is specially designed for breaking the ice. The "water-lines" are very full, and the "bow-lines" fine, the forefoot being cut away. When the vessel is trimmed by the stern for ice-breaking, and steams ahead, the bow presses the ice downward and breaks it. The shape of the bow is like a "spoon;" only that the stem projects somewhat further out than usual in steamers, forming an edge, which facilitates steering in open water. Two water-ballast tanks are built in each end of the vessel for trimming. By filling the two tanks aft, the draught aft is increased 4 ft. 2 in., whereby the propeller comes well below the water surface. The two forward tanks when filled increase the draught forward 4 ft. 11 in. The tanks are filled and emptied through a large centrifugal pump placed in the engine-room. It takes about six minutes to fill or empty each tank. The air pipes of the tanks have the same sectional area as the water-supply pipes, to avoid any undue pressure on the walls and top of the tanks if the pump is not stopped in the moment they are filled.

The machinery consists of a vertical compound engine, with two cylinders of 40 in. and 70 in. dia., by 36 in. stroke. To resist the strain brought on the machinery through shocks of the propeller against the ice, all parts are made extra strong—the shaft, for instance, is 20 per cent stronger than required by Lloyd's rules. A compound engine was chosen in preference to triple-expansion. This was done for the sake of the boilers. When the vessel has to break heavy ice by ramming, going forwards and backwards alternately at full speed, the steam pressure is very fluctua-

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ting, which would be trying to the boilers if the high pressure required by triple-expansion engines were used. On the other hand, the saving of fuel gained by triple expansion would not be great for the kind of service required by this ice-breaker. To get a low consumption the boilers are designed with large heating surface to a steam pressure of 100 lb. per square inch. For the same reason the engine is fitted with expansion slide.

The screw propeller is made very heavy, of cast steel, with loose blades that can be shifted while afloat. This is done by the following device, patented by Mr. Olsen, of Elsinore, and indicated in longitudinal section in the supplement. A well is built in the vessel right above the propeller, the top and sides can be shut air-tight. Access to the well is through a hatch in the upper deck. Through a large hole in the bottom of the well works a vertical tube, which can slide down to the boss round a propeller blade. Air is pumped into the well, which thus forms a diving bell. Spare propeller blades are stowed in the well. When the tube is hauled up, the lower opening in the vessel for the well is closed by a steel plate.

When the vessel is working in ice it is difficult to get the necessary cooling water for the surface condenser. There are three sea valves for the entrance of this water; namely, two in the engine-room, placed somewhat apart and at different heights, and a third in the foremost ballast tank aft, which can be opened and shut from the engine-room. When there is much ice, the valves are apt to get choked. The cooling water is then taken from the ballast tank and returned to this again. Now and then the water in the tank is renewed from the sea. If necessary the vessel is stopped to free the sea-valve of ice, as it is not so apt to choke then as when the vessel is moving. In this way it is possible to keep a good vacuum.

The vessel can carry 250 tons of coal. Loaded with 40 tons of coal and all four ballast tanks filled, the vessel easily maintains a speed of 12.75 knots, which requires 2,000 indicated horse power. The engines are able to develop 2,000 indicated horse power, which gives a speed of 13.4 knots when loaded as mentioned.

Probably no more ordinary ice-breaking steamers will be built for the Danish State railways, as ice-breaking railway ferries will be preferred. The first of these, the Jylland, given in Table I, has been built and proved successful. Her main features resemble those of the ordinary ice-breakers, but the length is relatively greater. Experience gained with existing ice-breakers shows that they work in ice as well going astern as ahead, and for this reason it is under consideration to build the next ice-breaking ferry with a propeller at each end, like those in America. The advantage gained is smaller draught; the only fear is, that the vessels being small compared to the American, each of the two engines may be rather small for the work.

PROGRESS OF WORK ON THE NEW BATTLESHIPS KEARSARGE, KENTUCKY AND ILLINOIS.

Work on the three new 11,500 ton battleships, Kearsarge, Kentucky, and Illinois is going forward rapidly at the yard of the Newport News Shipbuilding & Dry Dock Co., at Newport News, Va., and although work on the two first named ships was only commenced a year ago they are nearly one-half completed. Every department in this big yard is making a special effort to get the ships ready for sea. Work on the Illinois was only commenced a few months ago, but the hull plating is already up sufficiently to get a good idea of the finished ship. The illustration on the next page shows the Kearsarge and Kentucky as they now appear, almost hidden from view by the staging.

It has been the practice of this yard, and especially so under the present management, to introduce every possible labor saving device, and from pneumatic hand tools to giant electric traveling cranes this is very noticeable throughout. The structural material for the ships is handled by overhead cantilever-cranes, which will hoist a 13-ton load at the middle of the arm. One is driven by steam, the other by electricity.

Nearly all of the skin plating of the Kearsarge and Kentucky is in place, and the main decks are laid, and the protective decks well in hand. All the steel frame castings are in place, and on the Kearsarge the work of boring out the stern tubes and A frames is progressing. The heavy forged iron rudder frames are due soon at the works, when they will be speedily machined and shipped in place. The new ships are fitted with both bilge and docking keels. The latter extend fore and aft about two-thirds of the ship's length. Incandescent lights are placed at convenient intervals within the hull, so that 'tween deck work can go on in as good light as though the men were at work outside.

Work on the machinery has kept pace with the hulls. When the contracts for these ships were secured the company entered on a series of extensions which has not yet been completed. The original machine shop, 300 ft. long, was increased by a 200 ft. addition, now used as an erecting shop. In this much of the material for the engines of the battleships Kearsarge and Kentucky is ready, as shown in the illustrations. The old and new shops together are a splendid stretch of 500 ft. by 100 ft. floor space, with a height of 70 ft. to the peak of the roof. Both shops are served by electric traveling cranes, which can handle weights up to 100,000 pounds. Down the center of the shop a standard gauge railroad line, connecting with the system in the yard, permits the taking in of any work, direct from the railroad, alongside the machines it is intended for. Both the old and new shops have galleries, under which the small machine tools are arranged, and served by overhead electric jib cranes. The Kearsarge and Kentucky will each

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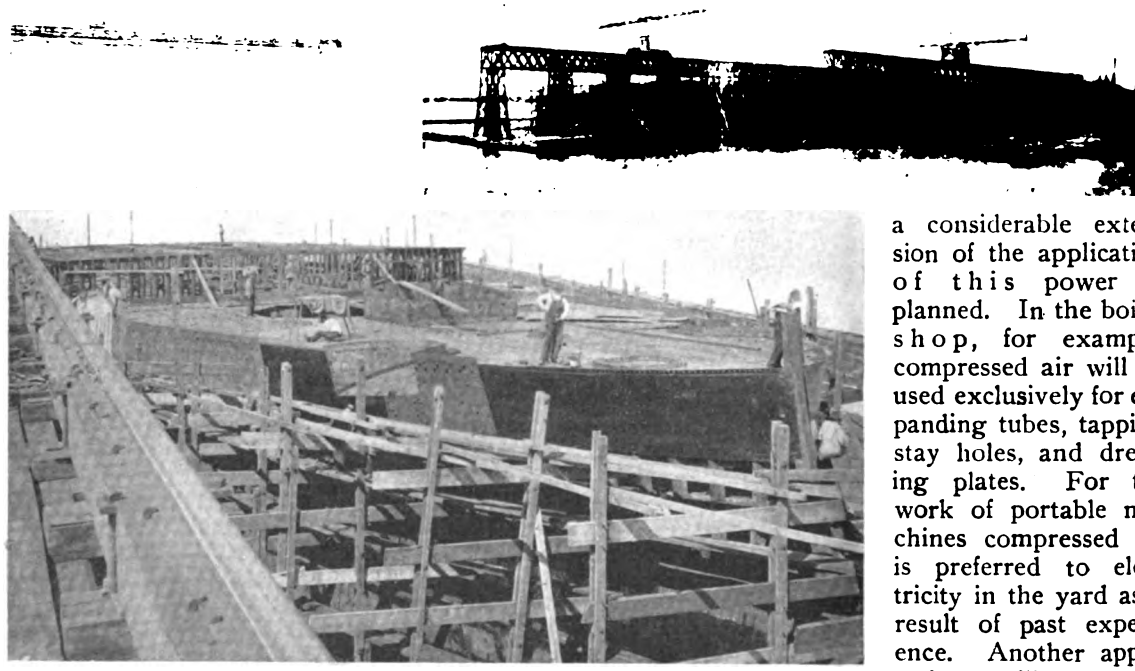
have two sets of triple-expansion engines of 10,000 I. H. P., propelling twin screws. The crank shafts and tail shafts are 14 3-4 in. dia., and the line shafts 14 in. The propellers are 16 ft. 9 in. dia. and 17 ft. pitch, each having 3 blades. The steel bed plates for the Kearsarge and Kentucky are laid out on blocking, with the crank shafts and bearings in place ready for the frames and cylinders and motions, as shown in the engraving. There is so much head room that the use of pits in the erecting shop is unnecessary. (The cylinders for each engine are first put top down on blocks and the frames, which are of forged steel, are fitted.) When this work, which is now going on, is finished the frames will be taken down and set up on the bed plates in their proper positions and the cylinders also hoisted on top. Six such engines as the battleships will carry make a very considerable showing of finished work in the erecting shop. On every side there are piles of piston and connecting rods, pistons, big ends, finished covers and valve gear, while the long lengths of finished shafting give a touch of resemblance to a gun factory. The machine and tool work is apparently of the very finest quality. In every detail a carefulness of finish is observable that in commercial work would be considered "impossible." Propeller hubs which are of manganese bronze, are a good example. These are machined as accurately as the bore of a cannon and even the curved outside portions between the blade seats are filed to a finished surface. In the boiler shop there is great activity and much of the work for the new ships is completed. The heavy machinery in this shop handles the work with ease. As the boilers are completed they are grouped in the yard, a recent view taken by our photographer showing the present accumulation. The Kearsarge and Kentucky will each have three double ended boilers and two single ended, all to work at a pressure of 180 pounds per square inch.

Among the improvements and additions before mentioned, which are taking shape, is a more extended use of compressed air. For some time the yard has done much small tool work, such as riveting chipping and caulking, by compressed air. This has been supplied by a compressor with a capacity of 560 cubic feet a minute. A new machine has been installed very recently with a capacity of 1,600 cubic feet, and a considerable extension of the application of this power is planned. In the boiler shop, for example, compressed air will be used exclusively for expanding tubes, tapping stay holes, and dressing plates. For the work of portable machines compressed air is preferred to electricity in the yard as a result of past experience. Another application will be the more novel one of driving by compressed air a large band saw mill now going up. The air will be converted into power by an ordinary steam engine, which will exhaust into an apparatus for ejecting the sawdust of the mill into the adjacent river; a use to which exhaust steam or electricity could not be put. Heretofore the company has bought its lumber dressed, but when the mill is in operation shipments of logs will be made by water alongside the mill and every foot used in the yards will be sawed there. All the wood which is used in the battleships is fire proofed with the exception of teak wood. The fire proofing is carried on in special apparatus capable of handling about 30,000 ft. of lumber a week. This consists primarily of a horizontal cylindrical pickling tank open at



BATTLESHIPS ON THE STOCKS AT NEWPORT NEWS SHIPYARD.

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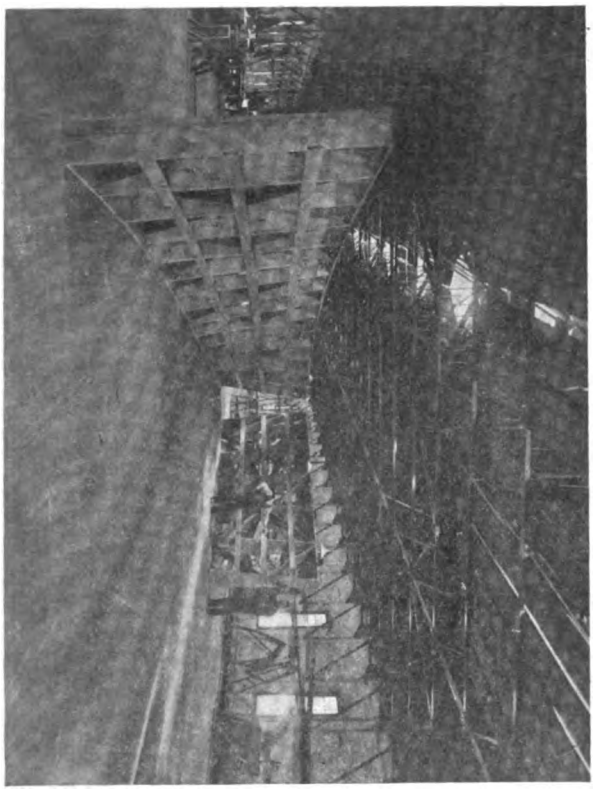
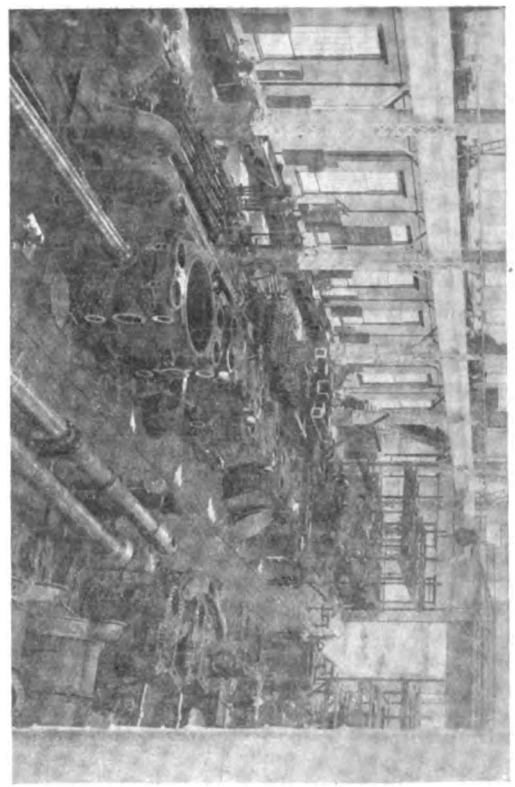
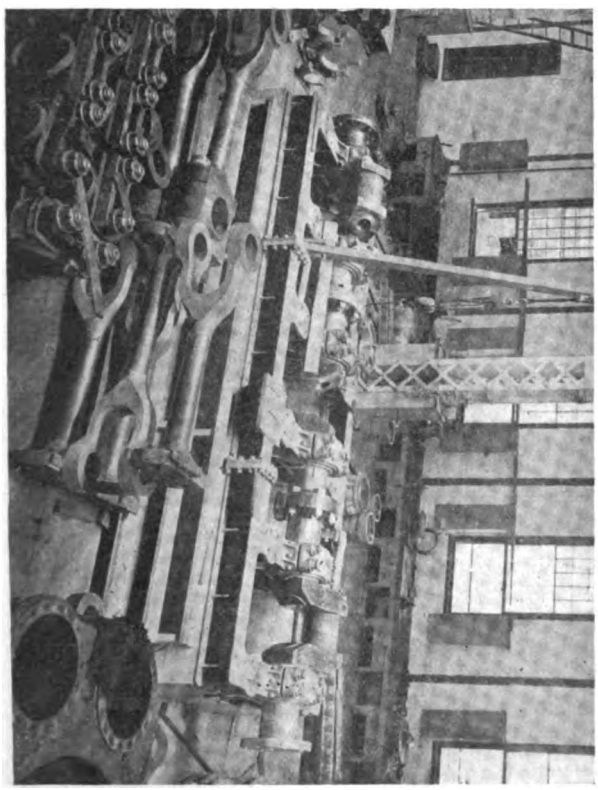


TEMPLATES FOR FORWARD ENDS OF ARMOR BELT, IN MOULD LOFT.

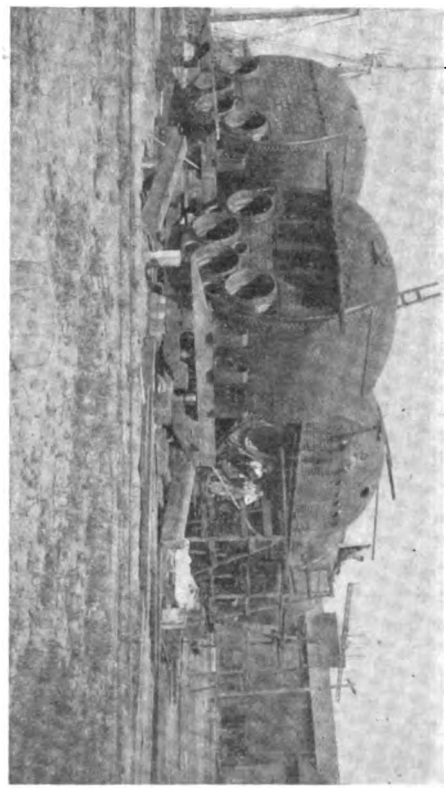


GENERAL VIEW OF ERECTING SHOP—STAGING AROUND ENGINES IN BACKGROUND.

(Views taken for Marine Engineering in Newport News Shipyard by Rusk & Shaw, Photographers.



BED PLATE AND CRANK SHAFT OF BATTLESHIP ENGINE.



GROUP OF DOUBLE-ENDED SCOTCH BOILERS FOR BATTLESHIPS.

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one end and fitted inside with rails, on which carriages which carry the lumber are rolled in and out. The tank is closed with a water tight door, and is tapped by pipes leading from vacuum and pressure pumps handling various chemical solutions. Another new apparatus, work upon which has commenced in the shops, is a 140 ton jib crane, which will be operated entirely by electricity. This will be one of the most powerful of its kind anywhere.

The shops of the outfitting department are filled with work for the ships. Valves innumerable are ready for use, and besides there are many auxiliaries nearing completion and fittings for the plumbing and the sanitary and drainage systems of the vessels. The electrical apparatuses which will be used in the operation of the turrets and guns of the Kearsarge and Kentucky, will be furnished by outside contractors. This also will be the case with the hydraulic pumps which will do similar duty in the Illinois.

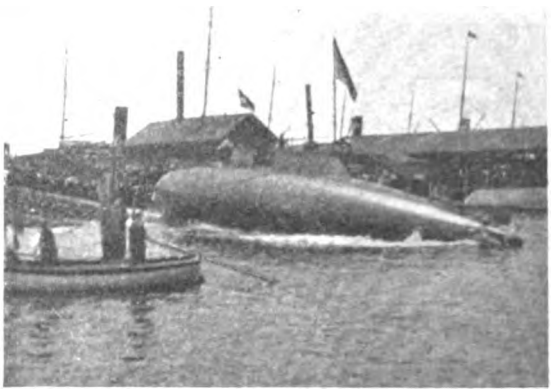
With the additions which have recently been made this yard is one of the best and most modernly equipped in existence, not excluding the best of the European establishments. The general superintendent is Sommers N. Smith, who is assisted by George Clarke, who was formerly and for many years the superintending engineer of the American line. To these gentlemen and to C. B. Orcutt, president, we are indebted for facilities afforded in inspecting the work and taking the photographs presented herewith.

Submarine Boat Plunger Launched.

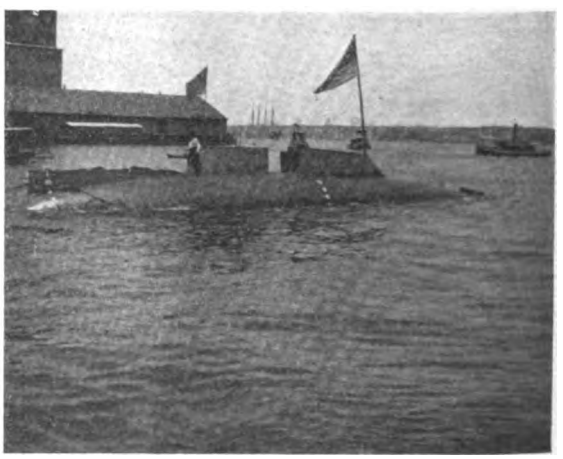
The United States submarine torpedo boat Plunger was launched at the Columbian Iron Works, Baltimore, August 6. This is the second vessel built from the plans of John P. Holland which has been put in the water recently. The other boat, the Holland, built by the Holland Torpedo Boat Co., at Nixon's yard, for private account, was illustrated and described in our June issue.

Although the Plunger was built under the supervision of John P. Holland and under his patents, certain modifications of design were imposed by the Navy Department, and thus in many ways, the boat differs from the Holland. The Plunger is of the familiar model, as will be seen in illustrations, being not unlike a gigantic Whitehead torpedo. She is 85 ft. long, over all; 11 1-2 ft. extreme dia., and has a total displacement of 168 tons, and light displacement of 154 tons. She is propelled on the surface by 3 independent sets of triple expansion steam engines, developing 1,625 I. H. P., and taking steam from a water-tube boiler, fitted with fuel oil burners. Submerged she is driven by an electric motor of 70 horse power. The armament consists of 2 under water torpedo tubes and a supply of 5 Whitehead torpedoes. At full speed when awash the Plunger is expected to have an endurance of 12 hours, and at slow speed a radius of action of 1,000 miles. Submerged she will have an endurance of 10 hours, at 6 knots speed.

When running awash the hull will be 3 feet below the surface, and the only portion visible will be the steel armor turret, 4t ft. high, protecting both the smoke pipe and the pilot. When about to dive, the fuel supply is cut off, and the furnace



sealed; at the same time an electric device lowers the smoke pipe and air shaft, and closes the turret opening with a sliding valve. Water is simultaneously admitted to the ballast tank, and in less than a minute the boat can be 3 fathoms down, running at the submerged speed. In the interior the machinery and appliances are very snugly fitted. In the forward end the torpedo gear is fitted, and aft of this comes the boiler clothed in asbestos, and then the engines, auxiliaries and the dynamo and switchboard.



Still further aft there is an air compressor. There are ballast tanks forward and aft and in the double bottom which can be emptied either by ejectors, power, or hand pumps. Her position axially in the water is regulated by automatic apparatus, and she can be steered in both vertical and horizontal planes, simultaneously, by the navigating officer. For the views of the launching and for particulars of the boat we are indebted to the courtesy of C. A. Morris, of the company.

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STEEL CONSIDERED AS A MATERIAL FOR SHIP CONSTRUCTION AND MACHINERY.

BY C. A. McALLISTER, FIRST ASST. ENGINEER, R.C.S.

In shipbuilding, probably more than in any art of construction, the selecting and testing of materials to be used is of prime importance. Now that steel has supplanted both wood and iron in this field, it is naturally the material which should be given the most attention. The first use of this metal for shipbuilding in this country is of comparatively recent date, as it was not until 1884 that the first all steel vessel was completed. Since that time great improvements have been made in the manufacture of steel, until now it is not only far superior to the best wrought iron, but of still more importance, a great deal cheaper. When first used in the construction of marine boilers, it was not only very expensive, but somewhat unsatisfactory as well. Many boiler makers were prejudiced against it, claiming that it was too unreliable for flanging and that it would not stand the great variations in temperature without cracking. At the present time it is safe to say that there are no marine boilers being built of wrought iron; thus demonstrating how these prejudices have been overcome, and what rapid advances have been made by the manufacturers of this material. In the construction of the new Navy, the Government has set the standard for the requirements under which steel has been manufactured for both hulls and boilers. These requirements have often been the subject of criticism and complaint, but the fact remains, as will be admitted by the manufacturers themselves, that these severe restrictions have spurred them on to raise the quality of their output; with a result that has been beneficial not only to shipbuilders, but to the makers as well. At the present time our mills are turning out the very finest grades of steel obtainable, and at a price which effectually bars competition from foreign countries.

As is well known, steel made by the Bessemer process is totally unfitted for use in marine construction on account of its lack of homogeneity, although instances may be cited where it has been used for hull plating. Steel made by the open hearth process is now almost universally adopted. Whether basic open hearth or acid open hearth steel is the better is an open question. Both processes have staunch adherents, but from such tests as I have seen of the products of the two systems, I would prefer acid steel, especially for plates which are to be flanged. For hull plating and shapes the usual requirements are a tensile strength varying from 55,000 to 65,000 lbs. per sq. in., and an elongation of not less than 25 per cent in a uniform length of 8 in. It is also customary to require specimens cut from the transverse edges of the plates to be bent over cold, flat on themselves, without showing signs of fracture. These requirements are very easily fulfilled and give a metal which is very ductile. It is not advisable to use steel of a high tensile strength for hull construction on account of its liability to fracture should the ship run aground or come in collision with another vessel. In ordering hull plating and shapes it is well to restrict the mill in regard to the limit of weights that will be permissable. Ordinarily plates as turned out from the mill will vary from 5 to 10 per cent below the calculated weights, to as high as 15 per cent in excess, due to negligence on account of the roller or in some cases to a desire of the men to increase their wages by turning out a large tonnage, where they are paid on that basis. This increase in weight of plating, it will readily be seen, will often result in increased draught and displacement of the vessel, to the discredit of the designer. If plates are rejected when they are more than 3 per cent in excess of the calculated weight or less than 5 per cent short, it will be found that the actual weight of the plating is surprisingly close to the original estimate. In an order embracing about 350 tons of hull plates I have seen the actual weight but 600 pounds less than the calculated. In such close restrictions on weights it should be borne in mind that the designed thickness is not always obtained. Many of the smaller patterns in an order are cut from large plates, which, owing to the spring of the rolls, are considerably thicker at the middle than at the edges. Thus, while fulfilling the requirements as to weight, it will be found that patterns cut from the edges of the plate are thinner than those cut from the center. In ordering hull plating another important point is to specify that tensile test pieces should not be cut from plates which are less than 1-4 in. in thickness. Plates which are rolled thinner than that always show a higher tensile strength and a correspondingly lower elongation, owing to the greater amount of rolling which they receive.

The rapid increase in the working pressure of steam used in connection with triple and quadruple expansion engines has called for higher tensile strength of boiler plates. As the thickness of the shells of large marine boilers has now almost reached the practical limit, a still higher tensile strength is demanded. With the advent of nickel steel the desired increased strength, and consequent decrease in thickness, seems to have been obtained. Thus far the use of nickel steel has been somewhat delayed on account of its expense and the seeming impossibility of getting smooth surfaces on the plates. This latter difficulty I am informed is being gradually overcome by one of the leading mills at Pittsburg, where a series of experiments has been conducted with various devices for the removal of the scale while the plates are being rolled. Carbon steel plates with a tensile strength as high as 80,000 lbs. have been made and used, but it is the opinion of many steel makers that such plates are liable to crack when subjected to the varying temperatures experienced in every day use. The ordinary requirements for shell plate now are a tensile strength of 60,000 to 68,000 lbs. per sq. in., and an elongation of not less than 25 per cent in a length of 8 in. Trans-

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verse samples cut from the plates are required to be bent over a curve whose diameter is equal to the thickness of the plate, after being heated to a cherry red and quenched in water at a mild temperature. For flange plates and plates coming in contact with the fire, the usual requirements are a tensile strength of not less than 50,000 to 52,000 lbs. per sq. in. and not greater than 58,000 to 60,000 lbs. The elongations usually called for are equivalent to a stretch of not less than 28 per cent in a length of 8 in. The bending requirements are usually the same as those for the hull plates, although no difficulty is experienced in hammering such test pieces down flat on themselves, without fracture. All of the foregoing requirements are easily complied with by the first-class steel makers, and results far in excess are daily obtained.

In order to do away with the central circumferential seam in single ended Scotch boilers, many are now designed with the entire shell in two plates. At first the manufacturers did not take kindly to rolling such enormous plates, but after some experience they are now willing to roll plates weighing as high as 10,000 lbs. each, and shearing to so great a width as 119 in. The advantages of such wide plates, with the consequent omission of one circumferential steam, are too apparent to need mentioning here.

In order to avoid excess of weight in marine boilers, some restrictions should be put on the thicknesses of the plates. In no case should the shell plates be rolled with the thickness at any point less than that for which it is designed. With the rolls in their ordinary condition it will be found in rolling a plate 110 in. or more in width that the thickness at the center is often as high as 1-8 in. in excess of that at the edges. With newly turned rolls and great care on the part of the roller this variance can be considerably reduced. The following allowances represent a fair limit of variation between the desired and the extreme thicknesses at any part of the plates. Plates under 60 in. in width not more than .04 in.; from 60 to 90 in. in width, not more than .05 in.; from 90 to 110 in., not more than .07 in., and for plates over 110 in. in width, not more than .09 in. thicker at any point than that specified.

In the manufacture of cast steel, as well as plate steel, the improvements have been rapid. While the first vessels of the new Navy were building it was almost impossible to obtain steel castings for cylinder heads and pistons which were not full of blow holes and unfitted for use. In many instances nine or ten castings were made before a sound one could be obtained. For a time it seemed as if no cast steel would be used for marine work. In the last four or five years, however, cast steel is coming in use to a greater extent than was at first anticipated. It is of rare occurrence that sound castings are not obtained at the first or possibly the second attempts. Pistons, cylinder heads, cross heads and slippers, propellers, and even crank shafts are being made from cast steel, with excellent results. The usual physical requirements for this material are a tensile strength of not less than 60,000 lbs. per sq. in. and an elongation of not less than 15 per cent in a length of 8 in. for all castings for moving parts of the machinery, and at least 10 per cent for other castings. Samples cut from castings for moving parts of machinery are required to bend through an angle of 120 deg. without showing cracks or flaws, and through an angle of 90 deg. for other castings. These requirements are very lenient, and are almost always exceeded, as all castings are annealed before they leave the foundry. One sample in particular, I remember, would have fulfilled the requirements for boiler shell plates, as it gave a tensile strength of 63,000 lbs. and an elongation of 27.5 per cent in 8 in., while the bending piece was hammered over so that the ends were parallel without breaking. For shaft struts, stems, stern posts and rudder frames cast steel has no equal.

CRANK AND OTHER SHAFTS USED IN THE MERCANTILE MARINE.*

BY G. W. MANUEL, R.N.R.

I have selected this subject, as the failure and breakage of shafting in the mercantile marine, though not so frequent, still goes on, as recorded in the newspapers, causing loss and detention to the shipowner, and anxiety to all concerned. Papers have been read and discussed, here and elsewhere, connected with this subject, chiefly dealing with the calculations relating to the twisting and bending moments, effects of the angles of cranks, etc. It is not my intention to trouble you with calculations on this, your Jubilee trip, but rather to give you the results of experience of the working of these shafts, under the calculations already made for us by the Board of Trade and Lloyd's Register of Shipping, which govern the minimum dimensions of all these shafts in the mercantile marine of this country. I will begin by allowing that all shafts fitted in new steamers are likely to be in line, and fair with one another from crank to propeller shaft, when the completion of coupling-up is done after the steamer is launched and is water-borne, therefore I do not take fitting of this description into account. After the bearings are adjusted, engines set to work, and the voyage begins, and the power to give the required full speed exerted, then, owing to insufficient bearing surface, the oil for lubrication gets squeezed out, and the metal of the shaft and bearings gets too close together, causing excessive friction; hot bearings commence, and it may be one or two bearing nuts are slacked back, and salt water as well as oil, used for the rest of the voyage, causing the bearings to get rough. The shaft is strained by alternate bending, heating, and cooling suddenly, and when continued, it gets out of line; fractures begin, until the shaft breaks at sea, or has to be taken out on arrival in

*Read at the International Congress of Naval Architects and Marine Engineers, at the Imperial Institute, London, 1897.

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port. I have known the crank pin bearings under such circumstances to require renewal after a voyage of only 6,000 miles, in spite of many gallons of oil wasted, and the main bearing to require to be lined up after running half that distance. The failure in this case is due to the engine builder, who also may have had pressure put on by the owner to get the engines into as little space and made as light as possible, added to the rivalry due to competition with other builders.

Allowing that the bearing surfaces are of good proportion, damage to shafts occurs from want of proper lubrication, or dirt and grit getting into the bearings, and the engine not being slowed down or stopped in time, before the heat becomes excessive so as to melt the bearing metal. Cold sea water is suddenly applied while the surface of the shaft is expanded by heat, causing the surface flaws to commence by sudden contraction locally, or hidden flaws to open out, especially where the shaft is made of non-homogeneous material, which may eventually cause it to give way, or to be renewed in harbor. The failure in this case is primarily due to want of judgment, or neglect on the part of the engineer or men in charge.

It has sometimes occurred when loading vacant parts of holds adjacent to the engines, that hundreds of tons of metal blocks or bars have been put in a short space, with ordinary light cargo in the same hold. The steamer's hull becomes locally deflected with such treatment, also the shaft, and under the influence of heavy weather combined, the shaft is strained and flaws commence, ending as before. This failure is due to want of consideration by those in charge of the storage of the vessel. I would here mention that weak engine seatings, defective bearings, brittle steel bedplates and framings supporting the engines, have caused the breakage and failure of shafts. These failures are due to ship and engine-builders' designs.

It is well known that engines in twin screw steamers, originally designed to lessen the danger of accident, have not lessened the breakages of their shafts, though they have been able, after the shaft of one engine has given way, to make their port with the other engine. I refer more particularly to the large class of ocean steamers and also smaller class, both having large horse-power. In some cases the shafts have been insufficiently supported by the ship's hull, at a considerable distance from the center of the vessel, their bearings far apart, and the screw shaft unprotected and exposed to shocks of the sea in bad weather, added to the continual strains due to vibration of the ships themselves, which is in some cases considerable, causing alternate elongation and compression in the direction of the length of the shaft, and creating flaws on the surface circumferentially close to couplings and bearings, which eventually cause the destruction of the shaft. These failures are due to inefficient design of hull and bearings at the stern part of the vessel.

Hollow crank and screw shafts have been seldom used in ocean-going steamers of the mercantile marine; and except a test hole bored in the center of steel shafts forged from the ingot to ascertain if there is any cavity in the center, or what is termed piping, which hole does not exceed 2 1-2 in. dia. in large shafts, made by the manufacturer, these shafts are generally solid shafts. Shafts generally give way from flaws near the surface, and would give way earlier at sea if they were hollow and not supported by the metal next the center. I have seen several solid shafts with serious flaws extending inwards 3 in. from the circumference bring the vessel full speed into port, whereas if made hollow they would have broken at sea. In cases where hollow shafts were used they gave out at sea. Failures in these cases are through design. Where improvements have been made to remedy the defects I have mentioned, ocean-going steamers are now driven at full speed on a voyage of 12,000 miles with no salt water on the bearings for years, and free from mishaps. I may here say that the use of triple and quadruple engines, by reducing vibration as compared with the irregular motion of the two-crank engines, tends to increase the life of these shafts, and that part of the power formerly wasted in vibrating the vessel is now utilized in propelling it. In spite of all these improvements relating to design, there remains the serious question of defective and variety of quality of the material which these shafts are composed of, and many have given way at sea and also been condemned through no other cause than original defects in material and process of construction.

Iron is now less used, especially for crank shafts; steel is gradually taking its place in ocean-going steamers, except for propeller shafts. Iron shafts are, I may say, made up of thousands of small pieces of selected iron, generally termed scrap, cuttings of old iron boiler plates, good navy ship iron, cuttings off forgings, old bolts, horse shoes, angle iron, all welded together, forged into billets, re-heated, and rolled into bars, cut into lengths, and formed into slabs of suitable size for welding up into the shaft. Before the use of steel generally, considerable improvement on the old method of fagoting, so-called, has been made, more powerful forging hammers used, along with more suitable furnaces and fuel; still, with all this care, I may say there is not an iron shaft without flaws or defects more or less, and when these flaws became placed during the construction of the shaft, in proximity to the greatest strain, and though there was no hot bearing—which no doubt would have made matters worse—they often extended until the shaft became unseaworthy. Even with the best wrought iron that could be made of the finest scrap from the best qualities of selected brands, iron shafts are 60 per cent inferior in strength to the best mild cast steel made on the open-hearth system, cast into ingots, and forged down under the hammer or hydraulic press.

After the introduction of mild steel for the con-

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struction of vessels there resulted an accumulation of cuttings from ships' plates, etc., and it was then considered desirable and economical to work this scrap steel into piston rods and shafts. But shafts made in this manner, though stronger than iron, as regards tensile strength, contained similar defects to that of iron, added to inequality of the material, in some parts hard and in others soft; also being made up of thousands of pieces, some of different steels, and the presence of dirt, etc., along with the fact that steel requires more care in welding than wrought iron, the shafts and piston rods made in this manner were found inferior to that made of good homogeneous steel forged from the ingot, or even good wrought iron, and some gave way.

I may here state that in the Peninsular and Oriental Company's service steel was used for crank shafts forged from the ingot as far back as 1863, then manufactured in Prussia by Messrs. Krupp, and generally known as Krupp's steel; the tensile strength was about forty tons per square inch, and, though free from flaws, they broke without warning. This steel was too brittle to withstand the strains of the engines, and its use was discontinued in the service and iron shafts again resorted to. Great improvements have been made by Messrs. Krupp since then, and I am informed that their shafts are now of excellent quality.

Attempts have been made to manufacture crank and other shafts machined direct from the mould after being annealed. The result generally ended in failures, as the material was wanting in that ductility and toughness necessary in crank and other shafts, and I think they are now seldom used.

The term mild steel applied to shafts in a general manner does not in my experience represent the condition of the shaft. I have found there are very great differences in the value and quality of mild steel, even as much as I found in wrought iron, depending largely on the qualities of the iron used and the chemical and moulding operations of converting it into steel. Also the amount and description of mechanical work applied when being forged into shafts. I attach a table showing these differences by actual test—Tables I and II. Mild steel was first used by the Peninsular and Oriental Steam Navigation Company in 1880; the dimensions of the shafts were limited by the same rules as those for wrought iron shafts. The steel was made by the best makers, having a tensile strength of 24 tons per sq. in., it being then considered inadvisable to exceed this limit on account of former experience with high tensile steel. The shafts made were crank shafts, and are still running; have been in use seventeen years; up to the present date no flaws of any description have been seen. The engines have been tripled, using the same shafts and bearings, and the working power increased. The percentage above the Board of Trade and Lloyd's rules, which fix the minimum size, is 24 per cent; a percentage above must be allowed, and has been the experience of all shipowners, varying from their record of mishaps and losses, and condemnation of shafts by the surveyors of the Board of Trade and Lloyd's Registry. Since these shafts were first used the tensile strength of mild steel has been gradually increased, and we are now using it at 32 tons per sq. in. possessing equal, if not more, ductility and toughness, to endure even greater strains than formerly. This has been arrived at by continued improvement in the manufacture by the makers, so that the percentage allowed above the rules is now reduced to only 6 per cent, leaving a very slight margin (Table III). I mention this as there is an opinion that the reason some shafts are so free from mishaps is owing to their dimensions being so much above the rules that regulate those sizes, instead of to the superior quality of the material used (Table II). The table given shows the results of steel tests made from 1880 up to the present time, independent of that done by the Board of Trade and Lloyd's.

Propellor shafts, until lately, have mostly been made of good wrought iron; steel, where it has been used in stern tubes and outside, where exposed to the action of sea water, has in many instances been reduced in diameter in a very short time, and in some cases the shafts have given way, and in others had to be taken out through corrosion. There is no doubt that steel, when exposed to sea water, corrodes more rapidly than wrought iron. Where steel is used and protected from the action of sea water it can be used with advantage. Different methods have been adopted to protect the steel. I give you one which has

TABLE I.—TESTS OF WROUGHT IRON USED FOR SHAFTS.

Tensile Tons.	Elongation in 5 in. per cent.	Bend.	Fractured Blows.	Broke Blows.	Fall of 10 cwt. in inches.	
			Ordinary shafts.			
18 Best	22 double	Good rolled into	9 scrap	11 4½ cwt.	12 blooms	C
18.6 Best iron.	24.3 three cut	Good good into	17 qualities,	18 rolled	12 into	C flat bars, and
				4½ cwt. blooms		
22	25	Good	21	32	12	C
22.9	23	"	12	14	"	T E □
21.9	25.7	"	15	21	"	P
22.3	26.7	"	12	19	"	C
22.4	28.6	"	22	30	"	P
24	27.6	"	20	28	"	Piston rod. 10 in. dia. B □

TABLE II.—TESTS OF STEEL.

Tensile Tons.	Elongation in 5 in. per cent.	Bend.	Fractured Blows.	Broke Blows.	Fall of 10 cwt. in inches.	
24	——	Good	52	60	12	
27	25.9	"	76	81	"	
28	21	"	26	32	"	F O
29.1	26.1	"	67	80	"	C ±
29.6	28.4	"	71	78	"	
29.7	27.1	"	70	86	"	D +
30.7	25.2	"	73	89	"	A +
32	26	"	70	89	"	
33.2	26	"	74	84	"	

[1] After being nicked all round with a chisel, this piece (A) was broken under a heavy hammer and stood 22 blows.

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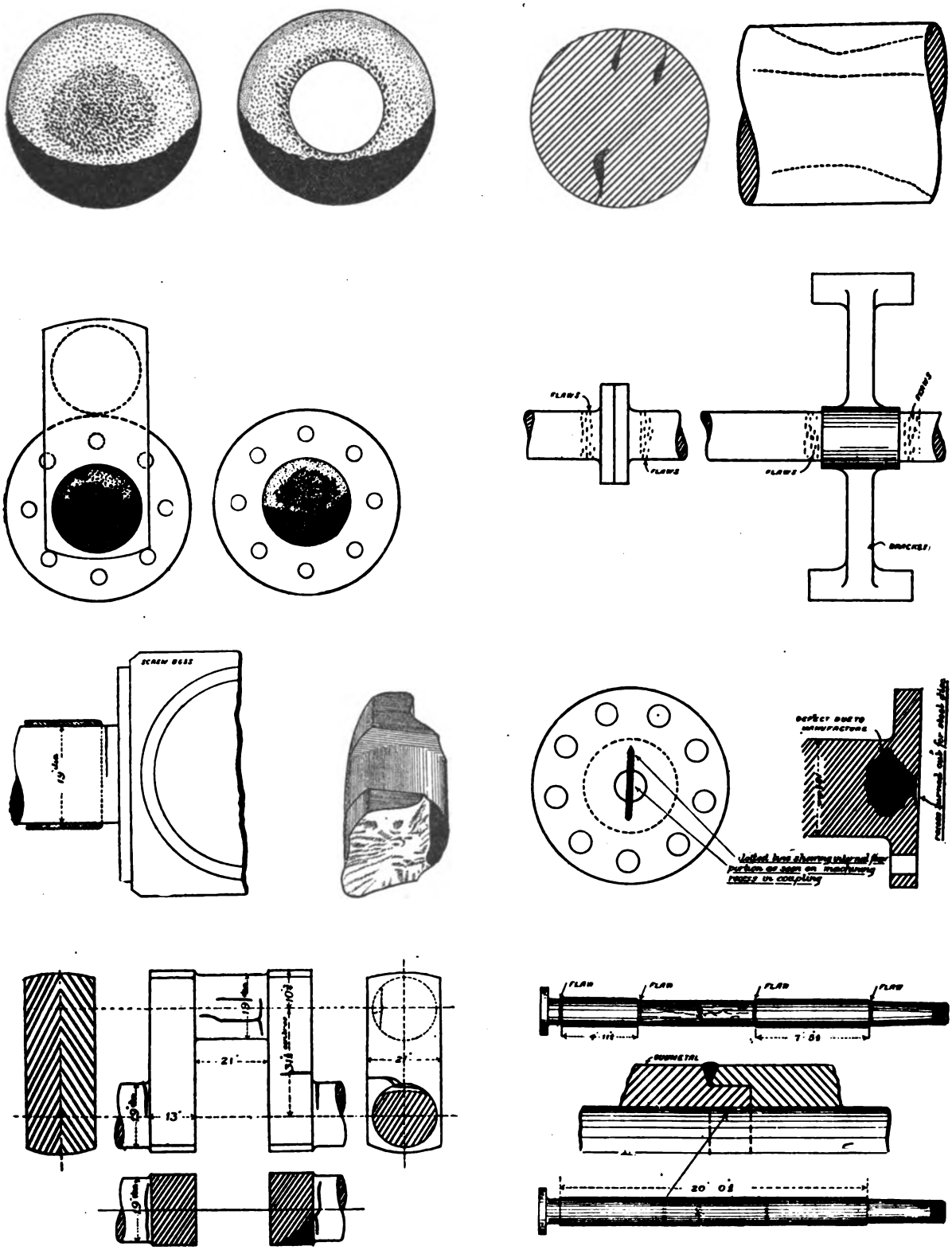
been so far successful. The best method would be to make the gun-metal covering in one piece, but this is an achievement not yet reached in large marine engineering practice. Before explaining the diagrams and tables I would add a few words about nickel steel.



SKETCHES SHOWING DEFECTS IN CRANK AND PROPELLER SHAFTS.

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Nickel steel has been lately used for the construction of shafts, and, while possessing a higher tensile strength, about 40 tons, it also possesses increased ductility and toughness. But, as the

TABLE III.

Year.	Percentage of Strength above Board of Trade Rules.	Tensile, Tons.	Material.
1879	26	18	Wrought Iron
1881	24	24	Steel
1887	14	28	"
1892	11	31	"
1897	6	32	"

price of this material is above that of the best mild steel, the shipowner would gain nothing by its use unless a corresponding reduction was allowed in the diameter, and, consequently, the weight of the shafts, for which purposes a modification of the Board of Trade and Lloyd's Rules would be desirable; this should only be granted on condition that a more severe test be applied than those at present, so that good and bad steels may be easily distinguished. In 1881, when mild steel was coming into use for shafts, in order to compare its value with the usual and best wrought iron, I had test pieces cut out of iron and steel shafts, made to the same dimensions, and tested in the same manner; the dimensions were 1 1-4 in. square by 13 in. long.

No. 1, cut from a rolled bar of best Staffordshire iron, not machined, broke at one blow. No. 2, cut from large chain iron, forged down to size and machined, broke at twenty blows. No. 3, cut from a new best wrought iron crank shaft forging, "machined only," broke at eleven blows. No. 4, cut from a new best mild steel crank shaft forging, and "machined only" stood sixty blows before breaking. These simple tests showed the great superiority of mild forged steel above that of the best forged iron for the construction of shafts.

After an experience of sixteen years, I have neither flaws nor breakages to report, while gradually reducing the margin of safety of these steel shafts from 24 per cent to 6 per cent.

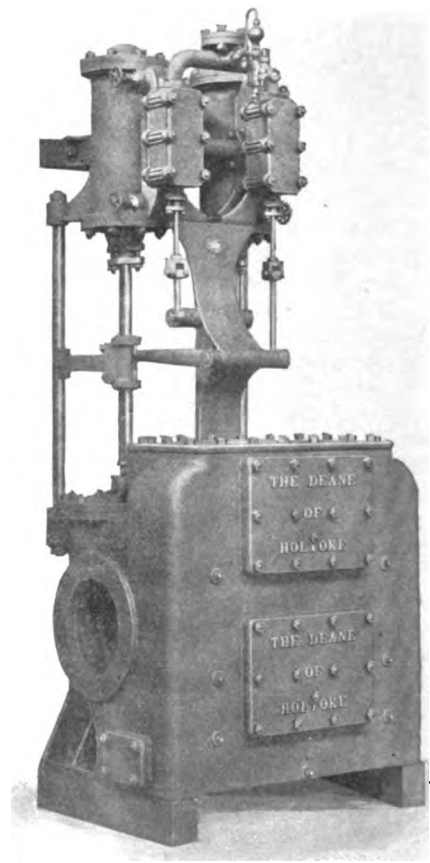
I give Tables I and II with more particulars of these tests of wrought iron and steel. Table III gives the gradual reduction of the factor of safety to present date. I conclude by stating that, amongst the many improvements in marine machinery made during the last sixty years, none has added so much to the safety and efficiency of ocean-going steamers as the manufacture of mild forged steel made by the best English makers.

The German steamship companies are following the example set by America in using nickel steel for propeller shafts. The new North German Lloyd steamships Kaiser Wilhelm der Grosse and Kaiser Friedrich will both be fitted with nickel steel propeller shafts for their twin engines. The shafts for the former will each have a length of 40.80 ft. and will weigh 185,650 lbs., while the Kaiser Friederich will have shafts 42.49 ft. long, which will weigh 155,060 lbs.

IMPROVED APPARATUS.

Deane Water Ballast Pump.

Water ballast has come to be so generally employed in vessels of all classes that there has been an accompanying development in the class of pumping machinery employed for this work. The problem for the inventor has been to design a pump which would be compact and light in weight, yet capable of delivering a large volume of water when necessary. The accompanying illustration shows a pump which fulfills these requirements. It is The Deane, of Holyoke, of the vertical duplex pattern. The material throughout is of the very best quality. Steel and composition are used for all working parts, thus insuring rigidity and strength. The floor space occupied is 3 ft. 2 in. by 3 ft. 9 in., and height 7 ft. 11 in., and the pump illustrated has a pair of 8 in. steam cylinders, a pair of 14 in. water plungers, and 16 in. stroke, and will deliver more than 2,100 gallons per minute when running at fair speed. These machines are built especially for marine service, but are very well suited to any



DEANE BALLAST PUMP.

work where maximum capacity is desired with minimum weight and space. Further particulars may be obtained by addressing The Deane Steam Pump Co., 72 Cortlandt street, New York.

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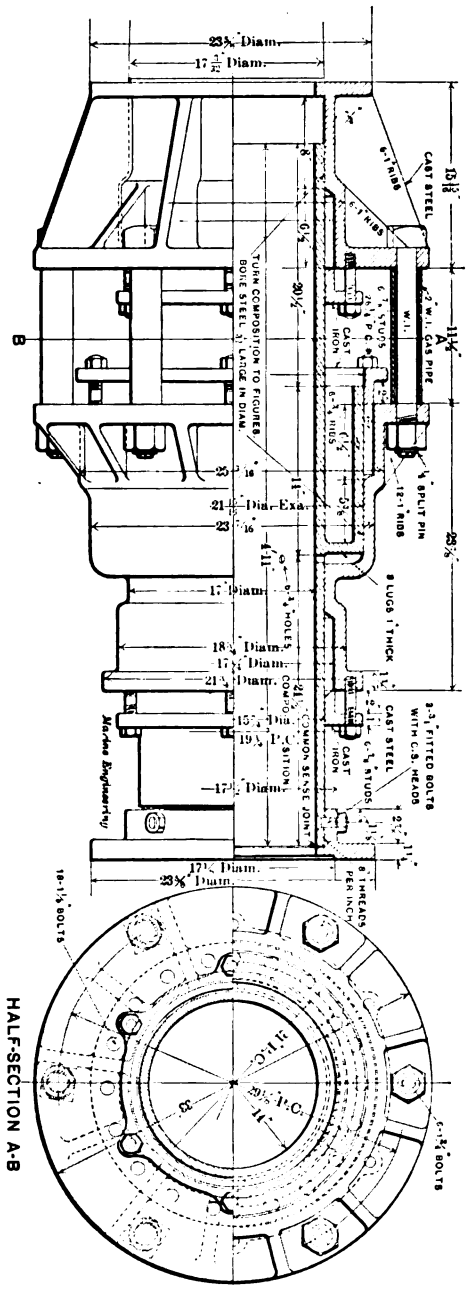
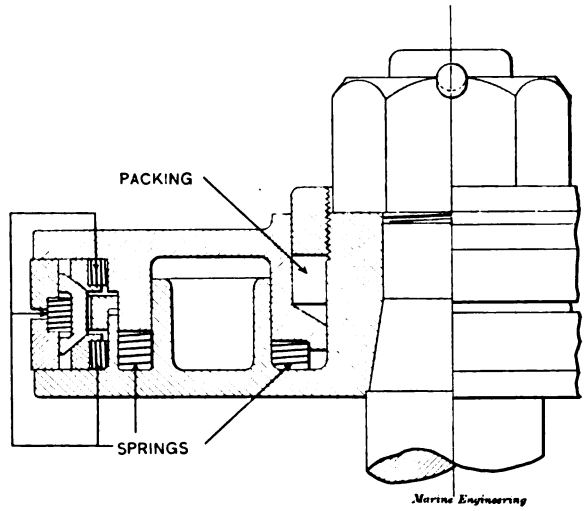
Balanced High-Pressure Expansion Joint.

In the equipment of a new twin-screw vessel at the yard of the Newport News Shipbuilding and Dry Dock Co., recently, it became necessary to make provision for the tremendous pressure which would be exerted in the way of thrust in the steam mains. In each this amounted by calculation to over 20 tons. To take care of this by ordinary expansion joints and some system of bracing was considered impracticable, or at best



SOMMERS SMITH EXPANSION JOINT.

not good practice. To meet the requirements Sommers N. Smith, the general superintendent of the yard, devised the balanced expansion joint, which is illustrated here. This was fitted in the ship and worked very effectively. On inspection of the sectional drawing it will be noticed that the inner tube has an increased diameter or ring about half way along its length. This forms a shoulder or piston at the end next



CAMPBELL SAFETY PISTON.

the bottom of the large stuffing box casting. The other end of this annular piston or ring is open and is steadied by the gland. In the inner tube below this ring there are holes, which admit steam from the main, back of the shoulder. As the exposed area of the shoulder or piston is equal to the area of the steam main the pressure in the main is equalized. Now, as the stuffing box is tied to the other end of the joint by long bolts the entire line of pipe is in a state of equilibrium, so far as the end pressure is concerned. The expansion due to heat is provided for by a liberal space for end play at the cast end of the joint. The advantages of such an appliance are manifest and the designer has made arrangements with H. B. Underwood & Co., 1025 Hamilton street, Philadelphia, for supplying the trade.

Safety Piston for High Speed Engines.

Mishaps to high speed engines, such as are used in torpedo boats, are frequently caused by water in the cylinders which relief valves cannot take care of. The danger from this cause has indeed seriously increased with the development of the modern fast running engine and it has been the aim of many designers to produce a device which will act as a safeguard. This is the idea carried out in the design of piston prepared by M. P. Campbell, of Portland, Ore. The accompanying sketch is self explanatory. It shows a solid piston at the crank end of the cylinder in a vertical engine, with an elastic top kept in place by packing in a stuffing box around the center of the piston, and held down with a screwed gland against springs, which will compress if under excessive pressure. The other springs and packing rings shown are made to suit the requirements of the cylinder wall pack-

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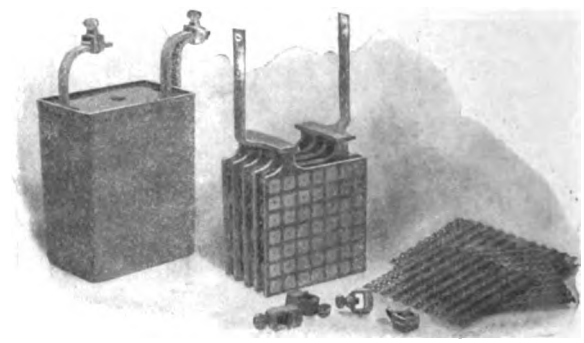
ing. This arrangement is applicable to both sides of a piston, if required. The inventor, M. P. Campbell, has applied for a patent.

A New Enamel Rheostat for Marine Plants.

Among the essentials for electric appliances on ship board are durability, ease of repair, and compactness. Inasmuch, too, as possible repairs may be required when thousands of miles away from where the article is made, necessary parts should be of small bulk so as to be conveniently carried as extras. The Universal Enamel Field Rheostat, manufactured by the American Electric Heating Corporation of Boston and New York, fulfills these requirements. The rheostat (a back view of which is shown in Fig. 1) consists of a round cast iron plate with a flat surface on the back to which are attached a series of enameled steel disks; projecting from the enamel are suitable copper terminals (which are connected to the resistance sections in the enamel) that provide means for connecting the resistance sections in series, and to the contacts on the front of the rheostat. Round headed brass bolts pass through lava bushings placed in holes in the iron plate, also through holes in the center of the steel enameled disks and holes in the ends of the copper terminals of the resistance embedded in the enamel. Each bolt, when a nut is screwed in place, holds a disk firmly to the plate and furnishes the contact on the front of the plate for the usual movable switch arm (shown in Fig. 2). The binding posts are insulated with lava and the whole is acid, fire, and moisture proof. While enamel rheostats have demonstrated their right to the first place in this class of apparatus by their many points of excellence, they were open to criticism from the marine engineer. Heretofore all the resistance of enamel rheostats had been placed in a single envelope of enamel and a fault anywhere in the circuit required practically a new rheostat, for defective circuits in enamel cannot be repaired. With the form of rheostat here illustrated every section of resistance is a single unit easily removed and replaced. Experience has shown that enamel resistance is sufficiently reliable to justify the claim that a stock of additional resistance sections equal to 10 per cent. of those in use would be ample for repairs for many years; as the disks are but 1 1-4 in. diameter by 1-8 in. in thickness it is clear that, as this is the only possible destructible element except the small insulators, this rheostat meets the requirements previously mentioned. By the use of enamel insulation the resistance element is in intimate contact yet thoroughly insulated from a relatively large radiating surface of a good heat conductor, and the resistance element is also hermetically sealed so that oxidation cannot take place. Because of this, resistance conductors of relatively small section can be operated and the whole made from one-fifth to one-tenth the bulk of the usual coiled wire rheostat. In the latter form air or at best asbestos insulation is depended upon; either of which being poor conductors, the wire must be of comparatively large section to withstand for a reasonable time the rapid oxidation incident to the high temperature, and the large size of wire necessitates greater length, and in consequence more bulk. In the enamel rheostat all of the structure is utilized for radiation when any part is working, while in the other case the supporting structure and idle parts are of little or no value for this purpose, and as but from one-third to one-half of a rheostat resistance is working when in service, it is obvious that much valuable space can be saved by the use of a well-designed enamel rheostat.

FIG. 1. NEW ENAMEL FIELD RHEOSTAT. FIG. 2.



COMPONENTS OF STORAGE BATTERY.

Lighting Sets for Small Vessels.

The problem of lighting in yachts, as compared with large mercantile vessels, is complicated often by the necessity for getting the electric plant into an extremely small space. Experience

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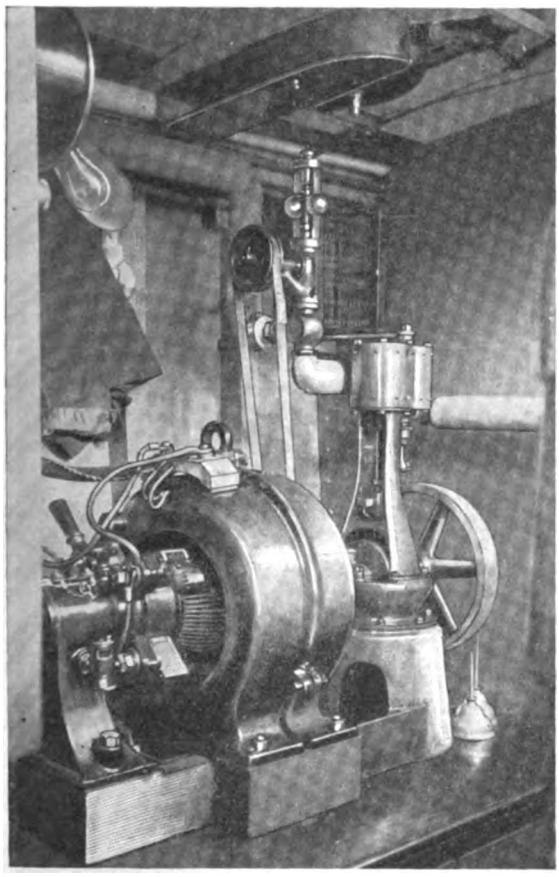
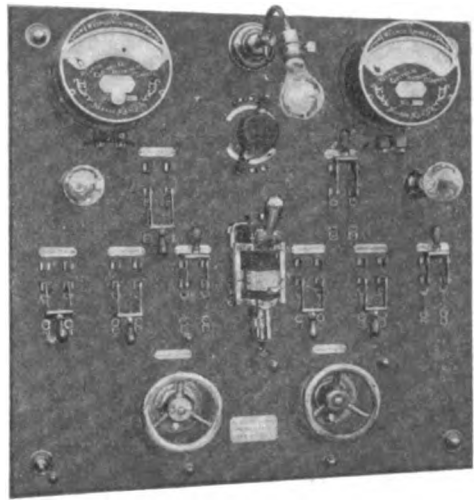
in this class of work, however, as in all other, has enabled designers to get results that at first thought would be considered impossible. Among the concerns which have made it a special study is the Electric Launch Co., of Morris Heights, N. Y. A typical installation is here illustrated and described. Each generating plant consists of a direct coupled engine and dynamo on one base. It is so compact that the set, together with the switchboard, is usually placed on a shelf in the engine room, as shown in the illustration of a recent installation. Steam is supplied from the yacht's boilers reduced to 100 lbs. pressure, if the pressure carried exceeds this. Each separate circuit of the yacht is carried to the switchboard, as shown, and is under the immediate control of the engineer. In all such installations storage batteries are fitted as an auxiliary source of power. Special care has been taken to simplify the methods of charging and maintenance. The battery plant consists of what are known as elements, inclosed in cells of hard rubber, with tight covers to prevent spilling in rough weather. The batteries, the construction of which is shown in the engraving, are usually placed under the flooring



LIGHTING SET IN YACHT.

in lead-lined trays, so that in case of breakage there will be no danger of hull corrosion. The batteries can always be charged when there is steam on the yacht's boilers, and when charged can be drawn on for a supply at any time. For lighting at night when the machinery is stopped, or while at anchor, the batteries are especially



SWITCH BOARD FOR YACHT SET.

useful, avoiding all vibration from the running of a dynamo. Electric fans too can be switched in circuit. There are also long periods during the day when the number of lights needed is small and the running of the dynamo for lighting is wasteful. The stored energy is then available and will last for days or weeks, if used sparingly, and while the boiler fires are banked or drawn. When occasional extra heavy loads, such as for search lights, projector or band lights, are demanded, the batteries can be used to augment the dynamo current. On the switchboard the volt meter is adjustable to show the E. M. F. of the dynamo or battery at will. The ammeter will also indicate either the current supplied by the dynamo to the lighting circuits, or to the battery while being charged, and will also show the rate of discharge of the battery. With an automatic underload switch in circuit the dynamo is always protected, if for any reason the speed and voltage of the dynamo should fall. This same automatic switch can be adjusted to protect the batteries from an over-load. Provision is also made for the using of lights while the battery is being charged, by the regulation or reduction of the E. M. F. to the normal volts of the incandescent lamps, it being understood that the voltage during the charging of the batteries is from 20 to 25 per cent higher than that required for the lamps. This surplus is absorbed, so to speak, by the regulating rheostat. This rheostat is also used to maintain the voltage at the lamps when supplied with current by the batteries; for, as is well known, the E. M. F., or voltage of storage batteries, falls about 10 per cent during discharge, this fall being allowed for by using enough calls to give the required voltage at the end of the discharge. The instruments are mounted on a marbelized (black or white) switchboard, and are well insulated and are easy of manipulation.

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There is some comfort to be taken from an inspection of the figures of shipbuilding, throughout the world, recently issued by the authoritative Lloyd's Register of British and Foreign Shipping. It shows that the United States had the second largest output of new shipping (iron and steel) during the year 1896. The figures for this country were 174,861 tons, or more than double those of Germany (80,478 tons), the next country on the list. This is the second year in succession in which the United States leads all other nations, excepting of course the United Kingdom, in the total tonnage. In 1895 the total for this country was 97,339 tons, against 80,430 tons for Germany, the third nation on the list. There was also the substantial increase of 77,522 tons for this country in 1896 over the total for 1897, whereas Germany enjoyed an increase of only 48 tons. The figures for the United Kingdom were large, the totals for 1895 footing 956,307 tons, and for 1896, 1,121,505 tons. Although this was a considerable increase, it shows, for the United Kingdom, a falling off in the proportion of tonnage built there, to the total tonnage of the world. The total for all countries in 1895 was 1,211,615 tons, and for 1896 1,478,375, giving the United Kingdom a percentage of 78.9 for the year 1895, and 75.86 for the year 1896. This however might have been caused by a falling off in orders of British shipowners; for during the year 1896 the British yards built 330,095 tons on foreign orders, an increase of 150,859 tons over the total tonnage built for foreign owners in 1895. This calls attention to the fact that the tonnage built by the nations other than the British is no index of the actual increase of tonnage owned by each nation. For instance, while Germany built 80,478 tons in her own yards during 1896, of which several thousand tons were for foreign owners, she had built in British yards a total of 124,193 tons, steam tonnage. The total new tonnage built in 1896 to sail under the German flag was 201,679 tons. Among other nations the only increase of importance is in the totals for France, coming next after Germany. In 1895 the tonnage built was 22,757 tons and in 1896 the total was 33,546 tons, an increase of nearly 50 per cent. These totals will likely be greater this year as the French line has decided to build two new 22-knot liners for the New York-Havre service. The figures here given represent the gross register of steamers and net register of sailing vessels.

The action of the steam yacht Hermione, in running away, after having collided with the Citizen's line steamer Saratoga, in the Hudson river, the night of July 29, has directed attention to the U. S. statute which applies to such cases. The Saratoga at the time had a large number of passengers aboard, and was on her regular trip from New York to Troy. The yacht struck her on the starboard side and wrecked the bar room and adjacent joiner work. Had the blow been delivered below the water line the steamer would in all probability have sunk. According to the most trustworthy of the newspaper reports, the yacht immediately steamed off, leaving her figure head and bowsprit on the steamer, and apparently having no concern whether the passengers sunk or swam. She had two bowplates stove in and put into Erie Basin for repairs, while the steamer continued on her trip to Troy. The Hermione was under charter at the time to a General Thomas, who is said not to have been aboard. The editor of Seaboard, in a recent issue, took notice of this cowardly act, and in a spirited paragraph directed the attention of the authorities to the action of the yacht. With his views we entirely agree. If there is any act within the power of man which is more utterly contemptible and despicable than the desertion of imperiled lives under such circumstances, we cannot even imagine it. In this case it was intensified, too, by the fact that the

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majority of persons on the Saratoga were passengers who would not be able to swim, or otherwise save themselves, in case the vessel suddenly foundered. So much for the moral side of the case, and now for the legal. September 4, 1890, Congress enacted a law which provided:

Section 1.—That in every case of collision between two vessels it shall be the duty of the master or person in charge of each vessel, if and so far as he can do so without serious danger to his own vessel, crew and passengers (if any), to stay by the other vessel until he has ascertained that she has no need of further assistance, and to render to the other vessel, her master, crew and passengers (if any), such assistance as may be practicable and as may be necessary in order to save them from any danger caused by the collision, and also to give to the master or person in charge of the other vessel the name of his own vessel and her port of registry, or the port or place to which she belongs, and also the names of the ports and places from which and to which she is bound. If he fails to do so, and no reasonable cause for such failure is shown, the collision shall, in the absence of proof to the contrary, be deemed to have been caused by his wrongful act, neglect or default.

Section 2.—That every master or person in charge of a United States vessel who fails, without reasonable cause, to render such assistance or give such information as aforesaid, shall be deemed guilty of a misdemeanor, and shall be liable to a penalty of one thousand dollars, or imprisonment for a term not exceeding two years; and for the above sum the vessel shall be liable, and may be seized and proceeded against by process in any district court of the United States by any person, one-half such sum to be payable to the informer and the other half to the United States.

An important decision under this law has recently been made in a suit in the U. S. Circuit Court of Appeals for the Fourth Circuit, which was heard by Circuit Judges Goff and Simonton, and District Judge Brawley, by whom the opinion was written. In a libel suit in the lower court, brought by the master of the schooner Morgan against the tug Hercules, to recover damages resulting from a collision, the Court found both vessels in fault and divided the damages. On behalf of the Morgan the appeal was taken. The evidence showed that during a thick fog at night, on the Atlantic, the tug struck the schooner on the port side, tearing such a hole in her side that she sank in seven hours. Both vessels were moving slowly and there was a heavy sea running. There was a conflict of testimony as to the action of the tug after the collision, but the lower court decided that she had run away. A proper lookout, however, had been kept on the tug, but the schooner was found to be at fault in not having a mechanical fog horn as the law directs. There was thus no blame attached to the tug up to the time of the collision, her liability for damages having to be determined solely upon her action in running away. "It would be a violent construction of the statute," said the Court of Appeals, "to hold that by reason of it alone the tug should be held responsible because of an omission of duty after the collision." Then continuing, the Court said: "The case would be different if there had been an absence of proof as to the collision itself; if, for example, the crew of the schooner had not been rescued, as happily they were, and for that or other reasons there was a lack of testimony respecting it, then the failure to stay by, unless explained, would have raised a presumption that the collision was caused by the wrongful act, neglect, or default of the master of the tug. It is in such cases that the statute becomes operative and, in 'absence of proof to the contrary,' fastens the responsibility upon those who, failing in one duty, which was plain, may reasonably be charged with that which was doubtful. When one, disregarding cries for assistance, runs away from the scene of a crime, a strong presumption arises that he has committed it; but where there is positive proof by eye-witnesses that he did not, he cannot be convicted of it simply because he ran away, although he might be convicted of running away, if that were made a penal offense. So we construe this statute to mean that, if a master of a vessel that has been in collision with another fails to stay by her, and shows no reasonable cause for such failure, the law will presume that the collision was caused by some negligent act or omission on his part, and in the absence of proof to the contrary, will fasten upon him the responsibility for the collision. It puts upon him the burden of showing that he was free from fault. It assumes that one who fails to offer assistance to those whose distress is caused by him is presumably at fault in the act which caused the distress, and it denounces pain and penalties against his inhumanity, and holds his ship responsible for the pecuniary fine; but it does not condemn without a hearing. The obligation imposed is not unqualified; it is carefully guarded by conditions; it permits presumptions to be rebutted by proofs, and it is only 'in the absence of proof to the contrary' that his responsibility is made absolute." This reasoning, of course, applied only to the civil proceeding to secure exemption from paying damages (which was granted), but the criminal negligence of the master of the tug is thus commented upon by the Court: "Conceding the correctness of the conclusion of the court below that the master of the tug failed to stay by and render assistance, his conduct is to be gravely reprehended, and in a proper proceeding doubtless he may be made to suffer the penal consequences that follow the violation of the statute." It will be interesting to note if a "proper proceeding" follows the collision between the Hermione and the Saratoga.

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International Meeting of the British Institution of Naval Architects.

The International meeting of the British Institution of Naval Architects, held in honor of the Diamond Jubilee of Queen Victoria, appears to have been one of the most successful gatherings of the kind on record. It was a sort of World's Congress in that it brought together prominent representatives of the mercantile and naval services of all maritime nations, and these visitors participated in the discussions of papers, which were read for the most part by British authors. There was a delegation from the United States including direct representatives of the Navy and members of the Society of Naval Architects and Marine Engineers. The American visitors who were received with extreme courtesy, included, among others: Naval Constructor, D. W. Taylor; Passed Assistant Engineer, Walter M. McFarland, U. S. N.; Lt. J. C. Colwell, U. S. N.; General Hyde, Charles Cramp, C. H. Haswell, C. H. Wheeler, and W. H. Shock. The proceedings were opened July 5, by a reception at the Hotel Cecil. Lord Hopetoun, president of the institution and a committee including the Lord Mayor of London, received the guests. On the following day the serious work of the Congress was begun at the Imperial Institute, the Prince of Wales delivering the address of welcome. Many distinguished representatives of the British Government were present. Then the Congress divided into two sections, the Naval Architects gathering in one hall, with Lord Hopetoun in the chair, and the Marine Engineers assembling under the presidency of Sir E. J. Reed.

A paper on "Hardened Plates and Broken Projectiles" was read before the Naval Architects by M. L. E. Bertin, France. In the discussion which followed Sir William White fairly divided the credit for armor plate improvement; France having produced the all steel plate, England the compound plate, America the Harveyised plate, and now Germany is endeavoring to still further improve the manufacture of thick armor plate. "Non-inflammable Wood" was the title of a paper read by Charles Ellis, Sheffield, England, which was entirely favorable to the process of fireproofing lumber used in ships.

In the engineering section a paper entitled "A Review of the History and Progress of Marine Engineering in the Royal Navy and Mercantile Marine," the joint labors of Sir A. J. Durston, Engineer-in-Chief of the British Navy, and J. T. Milton, Chief Engineer Surveyor of Lloyd's, was listened to with much interest. In the portion of this paper devoted to the navy the rise in steam pressure from 10 pounds per square inch, in vessels built in 1844, to 300 pounds, in the Pelorus of 1897, was graphically presented. The same means were used to illustrate the steady increase in piston speed per minute, from a speed of 434 ft. in the warship Warrior in 1861, to a speed of 1221 ft. in the destroyer Starfish at the present time. Also the increase in speed of revolution was noted. The Warrior in 1861 on full power trial gave 54.25 revolutions and the destroyer Boxer, one of the newest vessels, runs up to 410 revolutions. The greater part of this paper was devoted to a comparison of the machinery equipment of war vessels of the British Navy, and very little matter proportionately was given to the no less important subject of the advances made in the merchant marine. J. Leslie Robinson read a paper, for Pierre Sigaudy, France, on "Water tube boilers for high speed ocean steamers." This was a description of a possible instalment of boilers, of the "Normand et Sigaudy" type to give 23,000 H. P. As the paper dealt with one type of boiler only it was not as comprehensive as the title would suggest.

On the second day the most noteworthy paper of the Congress, on "The Advances made in the Mathematical Theory of Naval Architecture," was read by Sir Edward J. Reed, vice-president of the Institution. This was a very masterly exposition of the subject, and covered the period from the founding of the Institution in 1860 to the present time. In succession he discussed the subjects of strains in ships at sea and the necessary strength to withstand them, with the scientific facts which prescribe dimensions, forms and weights, so that vessels shall be possessed of stability under varying conditions of displacement, and also the adaptation of form to fluid resistances so that vessels may be propelled with proper regard for economy and safety. Captain I. C. Tuxen, Director of Naval Construction and Engineering in the Royal Danish Navy contributed a paper on "Danish Steam Ferries and Ice Breaking Steamers." In view of our own experiences with navigation in winter this paper was of special interest to the American visitors. It is reproduced elsewhere in this issue. A paper of a purely technical character describing a "Graphic Aid in Approximating Hull Weights" was read by J. Johnson, Gothenburg. Considerable interest was shown in the paper on "Crank and Other Shafts used in the Mercantile Marine," read by C. W. Manuel of the Peninsular and Oriental Steam Navigation Co. This will also be found in full in this issue. A paper illustrated by lantern slides giving an account of experimental investigation of the "Nature of Surface Resistance on Ships and in Pipes" was read by Professor H. S. Hele Shaw Liverpool. Sydney W. Barnaby read a paper on, "The Formation of Cavities in Water by Screw Propellers at High Speeds."

On the evening of July 7 the members and guests were present at a banquet in the King's Hall, Holborn Restaurant, London, the Earl of Hopetoun presiding. General Hyde of Bath, Maine, spoke for the United States in response to a toast, saying: "My Lords and Gentlemen—My only regret on this happy occasion is that Mr. Griscom, president of our society, is compelled to be absent. He could have responded to this toast so much more worthily. The hearty welcome you have given us, the kind hospitality you have shown us, will long linger in our memories. Our hearts were already warm towards the mother country. We have seen many things to interest us here. Not the least important is to learn how the great heart of England goes out toward her navy and her merchant marine. We have learned how the will of a great people, largely entrusted to members of your society, has produced your magnificent fleet, which by a seeming paradox, may be a promoter of peace while it is an engine of war. We can learn, as Lord Hopetoun so well expressed it, 'that England claims no monopoly in the art and improvement of ship building.' Gentlemen, in behalf of your kindred American society, I thank you."

The programme of festivities which occupied the following days, before the breaking up of the Congress, was carried out very successfully and was pronounced by all the foreign guests to be worthy of the best traditions of British hospitality. A trip was made in a special steamer on the Thames, during which the great bascule bridge at the Tower was examined, and visits paid to some of the great docks. A call was also made at the Thames Iron Works, long famous as the builder of many of the finest warships afloat. Work was progressing on the British battleship Albion, 12,950 tons, and on the Japanese battleship Shikishima, a vessel of 14,900 tons, which is designed to be the most powerful ship in any navy when ready for service. Guide books containing plans of the route were distributed among the visitors. In the evening a grand concert was given at the Queen's Hall, in honor of the foreign guests, at which the orchestra from the Royal College of Music, and the splendidly trained Leeds Festival Choir, which had come to London for the occasion, were present. On the following day an excursion to Portsmouth and Southampton was on the programme. By rail the members and visitors, who

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included naval officers of many nations, went down to the chief naval port of Britain. The Royal dockyards were opened wide to the visitors, who were permitted to view all of the shops. The only vessel under construction was the battleship Canopus, 12,950 tons, though there was much outfitting and repairing work going on. After looking over the plant the company was taken aboard the liner Mexican for a cruise in the Solent. A landing was made at Southampton where the new graving dock for the London and Southwestern Ry., 750 ft. by 91 ft. was viewed. The harbor improvement works, largely for the accommodation of the trans-Atlantic mail steamers, also created comment on account of their magnitude. The return to London was by train, and in the evening a reception was held at Lord Brassey's house in Park Lane.

On July 10, by special invitation of Queen Victoria the members of the Congress and friends journeyed to Windsor Castle to attend a garden party given in their honor. Every possible courtesy was shown the visitors at the Castle, and during the afternoon the Queen, accompanied by Princess Henry of Battenberg and Prince and Princess Charles of Denmark, drove slowly among the visitors, many of whom were introduced to her Majesty by Lord Hopetoun. Naval Constructor D. W. Taylor, U. S. N. had the honor of an introduction as official representative of the Navy Department. The grounds and apartments of the Castle were free of access to the visitors during the day. On the return journey a stop was made at Richmond where many took a drive through the park. Later dinner was served at the Star and Garter, with the Earl of Hopetoun presiding. The river Thames was lit up with colored fires, and there was a spectacular display of fireworks.

The trip to the North Country shipyards brought out a big delegation who took train for Glasgow. There the Fairfield Shipbuilding Co.'s yard at Govan was the first stop. The yard was specially interesting to the American visitors as birth place of the great Cunard trans-Atlantic record breakers. The work on hand in this yard included 56,300 tons of new shipping and 116,500 indicated horse power of machinery. Dinner was served here in the mould loft to which about 400 sat down. The members then proceeded down the Clyde to the yard of William Denny & Bros. at Dumbarton. Here the famous experimental tank was shown in operation. In the evening the members were entertained by the Lord Provost and Corporation of Glasgow at a conversazione in the City Chambers.

On July 14 the company was taken on a water excursion down the Firth of Clyde round Arran and Ailsa Craig. The day following on the return journey to London, a stop was made at the immense works of the consolidated firms of Sir W. G. Armstrong, Whitworth & Co., Newcastle-on-Tyne. In the shipbuilding department there were 14 vessels, ranging from a torpedo boat destroyer to a 14,800 ton armor clad, in various stages of construction. In the gun works 900 high powered cannon of all sizes up to 12 in. bore were being built. The steel works which can turn out more than 500 tons in a week also attracted attention, especially the heavy hydraulic presses in this department.

The American delegates before separating prepared an open letter addressed to the Secretary of the Institution of Naval Architects.

In this they expressed themselves as profoundly touched by the kindness and hospitality extended to them by the officers and members of the Institution, and desired to place on record their appreciation of the many courtesies they had received. They desired especially to thank the Rt. Hon. the Earl of Hopetoun, president, and Mr. George Holmes, secretary, for their kind attentions. They assured all their kind friends of the Institution that they would carry away the warmest feelings of affection and gratitude.

CORRESPONDENCE.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

A Response About Boiler Economy.

In reply to J. H. P., whose inquiry about water tube and Scotch boilers appears in your last issue, I would say that I think he does not thoroughly comprehend the work which a generator of steam for a marine steam engine is called upon to do. Its purpose is to supply steam at a fixed pressure continuously while the engines are running. The water tube boiler carrying comparatively little water is easily started into action, requiring a proportionally small amount of heat to raise steam up to the required pressure. Your correspondent assumes that it does so more economically than a Scotch boiler, but in this I am not prepared to agree. Does he know that bulk for bulk the water in the water tube boiler is heated to the required temperature by a smaller quantity of fuel than the water in the Scotch boiler? The wastefulness of the water tube boiler when running is due rather to imperfections in mechanical construction than to any inherent physical defects in the system. In the water tube boiler there is not that mechanical arrangement of parts which in the Scotch boiler permits of a proper combination and ignition of the gases in the combustion chamber, and provides a subsequent great area of tube surface, over which the gases must travel and give up their heat, before entering the uptake. If he has ever noted the uptake or chimney temperature in vessels fitted respectively with the Scotch boilers and the water tube boilers he will not be in much doubt as to the comparative heat absorbing efficiency of the types. Now as to the saving which might be effected at the end of a run by the use of a Scotch boiler: it is not hot water, or steam of pressure below that needed to develop the power of the engines, that is wanted, but steam of full pressure and plenty of it. So if a vessel had to make a full speed run almost to her destination, as for instance across-channel mail boats have to abroad, there would be no saving possible with any type. In the case of a steamship ending a trip in a port, where there was a necessity for slowing down a good deal, or making frequent stoppages of the engines, the Scotch boiler would apparently have an advantage. The heat stored up in the water would be plus the heat from the furnace, so that the fires in the latter could be slackened. But would not the heat contained in the water of a Scotch boiler, after the signal "finished with the engines," as compared with the smaller amount of water wasted in a water tube boiler, more than offset the small amount of coal saved by early cessation of firing in the Scotch boiler?

NORTH ATLANTIC.

"Practically the Same," with a Difference.

I have read with much interest in a recent issue your description of the Dublin Packet Company's vessels (new and old), and desire to direct attention to a very important feature developed by the performance of these vessels, which is deserving of serious consideration. I refer to the difference in indicated power. The hulls are practically the same in dimensions, and the speed attained is practically the same, yet the indicated horse power developed is twice as much in the new as in the old vessels. You will observe that the Ireland (of the old type) made the run in two hours and forty-five minutes, indicating 7,000 horse power; while the Leinster (of the

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new type), which develops 9,000 horse power when making 162 revolutions of the engines, was forced to 172 revolutions while making her fastest run in two hours and twenty-three minutes. The horse power indicated when making 172 revolutions is not stated, neither is the coal consumption per run given; yet I venture the opinion that the coal consumption per indicated horse power will be only one-half as much for the new as for the old vessels, and that the coal consumption per round trip will be about the same in both cases. The reason for this is simple: When steam is being used with moderate expansion the indicated horse power is not much in excess of the actual power. But when steam is used with excessive expansion, the indicated horse power may readily exceed by twice the actual power. There is probably no case on record so rich in object lessons as the record of these vessels. NEW ORLEANS.

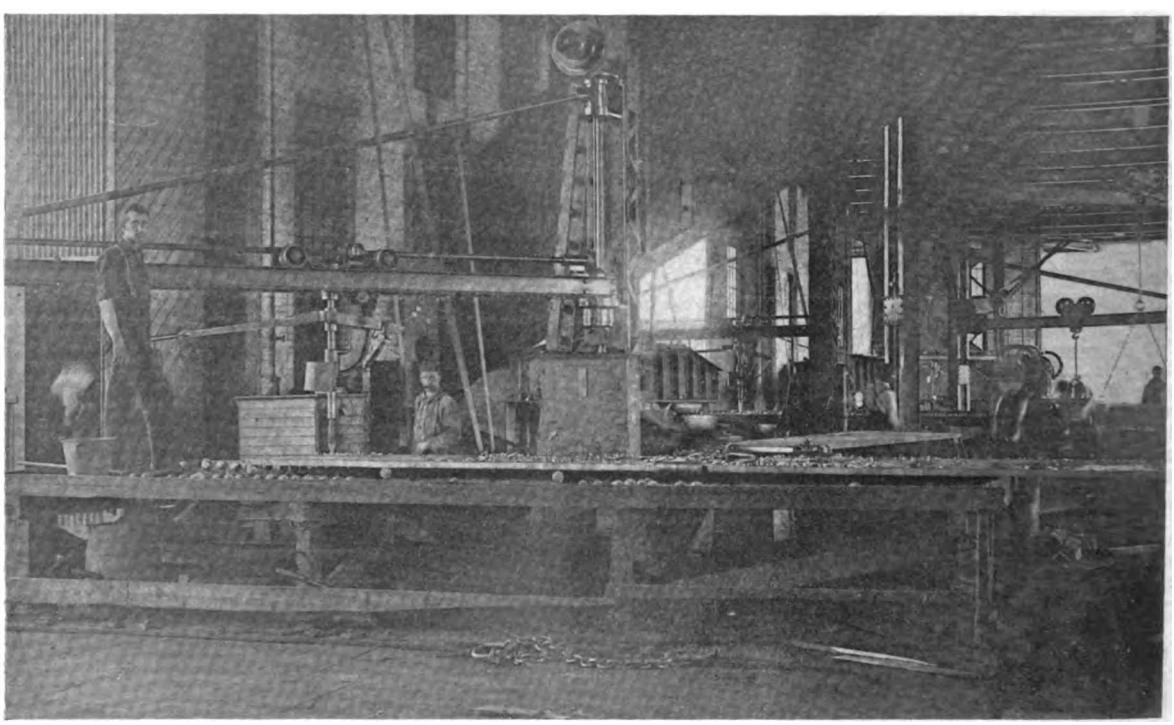
For Propeller Sharps with Secret (!) Formula.

We are designing and building steam engines and are now getting considerable custom in marine engines, and we are often asked, "How much power will be required to drive a boat at a given speed?" And also, "What size wheel will give this speed?" We put the matter in the form of queries which we should like to have answered. "Is there any rule for figuring the power required to propel a vessel at any given speed?" Also, "What is the power required to revolve a screw propeller at any given speed?" M. R.

Another Device for Shipyard Work.

In your August issue I notice a correspondent gives an account of a handy boiler shop tool in use at the Brooklyn navy yard. Well, we have a little labor saving device in use at our yard which I think would interest your readers. It is a plan for handling plates easily while countersinking the rivet holes. The photograph which I send gives a good idea of the device. A table about the height of a billiard table is built under an ordinary radial drill, which is fitted with the usual lever feed. On this table a number of cast iron balls, about 2 1-2 in. dia., are scattered about, and on top the plate to be countersunk is laid. The bed of the table is of wood so that the balls get a good grip on it, and the plate will not move unless lateral pressure is exerted on it. Then it will slide easily, and with this easy way of handling work, and the wide swing of the drill, one man can turn out a lot of work in a day. The advantages of this device are very apparent with heavy work. When the photograph was taken one of the heavy steel plates for the protective deck of one of the new battleships, building here, was on the table. This was a heavy job and would have been awkward to handle in the ordinary way. As you can see in the photograph the driller stood on top of the bed and moved the plate in any direction lengthwise or sidewise with his feet. It costs very little to put this sort of a device in a shop, and it saves lots of time and trouble. NEWPORT NEWS.

The Lake submarine boat Argonaut has been put in the water at the Columbian Iron Works, Baltimore. She is designed to travel on the bottom of rivers and harbors, chiefly for wrecking purposes. The patent specifications of this vessel, together with a sectional view, were published in our June issue. The boat is 36 ft. long and 9 ft. extreme diameter. She is fitted with a gasoline engine of 30 H. P., and storage batteries supplying an electric motor with current. A surface speed of 8 miles an hour is looked for, and it is expected that she will creep along the bottom at a speed of about 5 miles an hour. The boat is fitted with air locks, so that divers can have egress and ingress while she is on the bottom.



DRILLING TABLE FOR SHIPYARD WORK.

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EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—III.

BY WM. BAXTER, JR.

In the last article it was stated that if a wire is moved across a magnetic field an electric current will be developed in it. Strictly speaking, this statement is not correct; the effect of the movement is to develop an electro motive force. An electro motive force is a force that will set an electric current in motion providing there is a complete circuit for it to

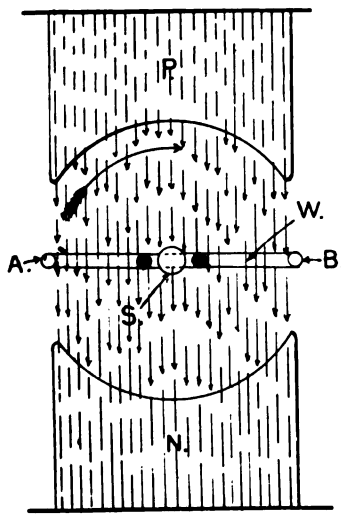

FIG. 12.

circulate in. If the circuit is not complete, the force can only develop an electrical pressure, or difference of potential, as it is called. To illustrate this point

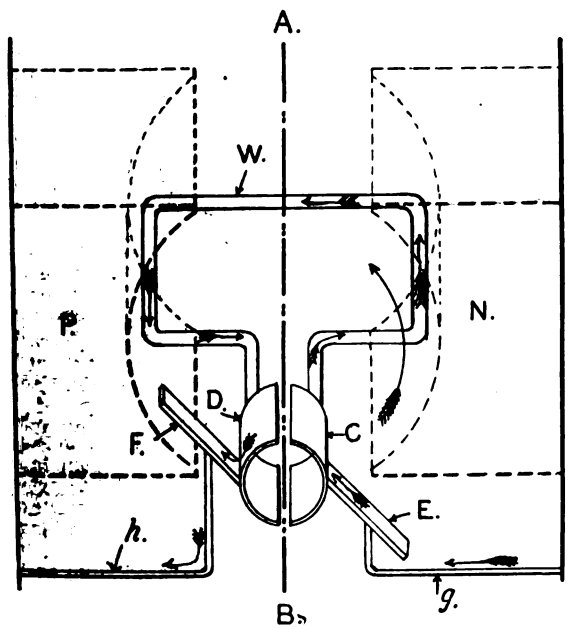

FIG. 13.

more clearly, suppose you have a pipe formed into the shape of an endless ring, and that at any point in it a propeller wheel is inserted. If the pipe is filled with water, it will be set in motion as soon as the wheel begins to rotate. If at any point in the pipe a valve is interposed, the shutting of this will cause the flow of water to stop, but if the propeller continues to revolve, it will still develop a pressure, notwithstanding that it cannot impart motion to the water. If the valve is opened slightly, a small amount of water will pass through, and the more it is opened the greater the flow. If you take a wire formed into an endless loop, or ring, and pass one side of it through a magnetic field, an electric current will be developed. The part of the wire that passes through the field develops an electrical pressure just as the propeller does in the case of the water pipe. If the wire is cut at any point, the current will stop, the cut acting in the same way with respect to the wire as the valve does with respect to the pipe. If the two ends of the wire are connected by means of a small wire a current will at once begin to flow. In the case of the pipe, the amount of water that will pass through the valve in a given time will be in proportion to the amount of opening, or, in other words, to the resistance that has to be overcome. With the electric current the action is precisely the same. In the water pipe the resistance is increased by reducing the opening through the valve, and in the wire loop it is increased by increasing the length or reducing the diameter of the wire that connects the two ends.

The direction in which the electric current will flow in a wire moved across a magnetic field will depend upon the direction in which it is moved with respect to the direction of the lines of force. In Fig. 12, if the loop is rotated in the direction indicated by the arrow the current developed in the side B will flow toward the observer, and in the side A, away from him. If instead of rotating the loop, it is moved bodily to the left, by moving the shaft S in the direction of A, the current in side B will still flow toward the observer. The current in B will have the same direction whether the loop is moved to the left in its central position or is raised close to pole P or depressed close to pole N. From this we can see that the direction of the current is not dependent upon the direction of rotation of the loop, but wholly upon the direction in which the wire moves across the lines of force, and that if it passes from the right to the left side the current will flow up to the observer, regardless of how the motion is obtained. This shows

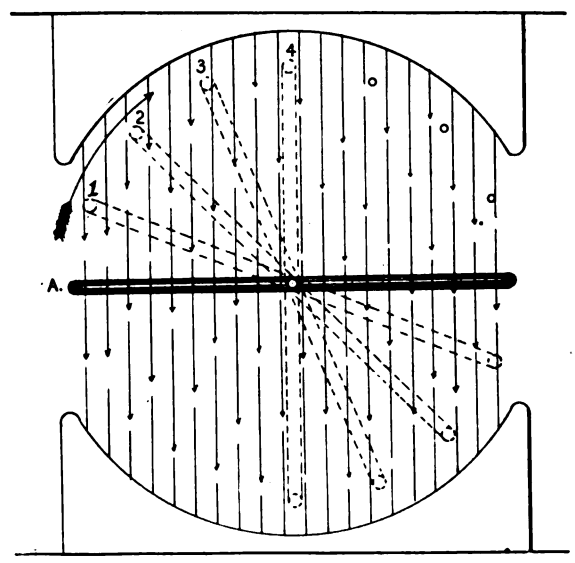

FIG. 14.

us, at once, that whichever way the loop is rotated, from the position shown in the figure, the current in side B will be the same. This is due to the fact that,

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as the loop is at right angles with the lines of force, the result of turning it in any direction will be to cause side B to move toward the left. If the loop was placed ninety degrees ahead of its present position, movement in opposite directions would cause the current in side B to be in opposite directions, because then sides A and B would be directly under the poles and in the center of the stream of lines of force; therefor, movement in opposite directions would cut the lines in opposite directions.

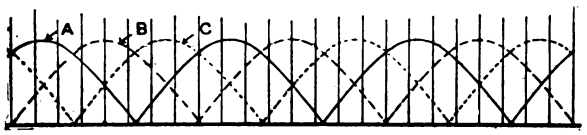

FIG. 17.

By carefully considering the foregoing explanations we can understand how it is that if the loop is rotated continuously in the same direction, the current in the wire will have its direction reversed twice in each revolution. To see this clearly all we have to do is to remember that the wire moving from the position of B toward that of A has a current developed in it, up from the paper, while the wire moving from the position of A to that of B has a current developed in it, down through the paper. The current in B will be up until it reaches the position of A, then it will reverse and flow down during the movement through the next half revolution. Commencing on the second turn the current will be up, through the first half revolution, and then down through the second half.

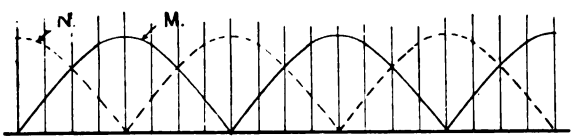

FIG. 16.

Currents of this class which run first in one direction and then in the other, are called alternating, and are used very extensively for the transmission of power on a large scale, but for lighting in cities and aboard ship, and for the operation of small motors, currents that flow continuously in the same direction are required. The generators used to develop such currents are constructed upon the principle illustrated in Figs. 11 and 12, and more fully in Fig. 13. The simplicity of these diagrams is not maintained in the actual machines, but for all that the principles involved in their operation are the same.

From the explanations given of Figs. 11 and 12, it will be noticed that there is no way in which the revolving loop can be moved so as to develop a current that flows in the same direction continuously. This being the case, it is necessary to have some device by means of which the alternating current developed in the loop may be converted into a continuous one in the outside circuit. The device used for that purpose is the part of the machine known as the commutator. The manner in which it accomplishes the rectification of the current can be made quite clear in connection with Fig. 13.

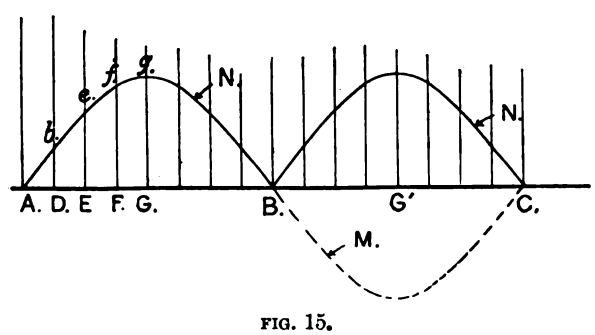

FIG. 15.

The ends of the loop W are attached to two halves, C D, of a cylinder, these halves being electrically insulated from each other, that is, there is no metallic connection between them. If the loop is rotated around the line A B in the direction indicated by the arrow, the current will flow from the end attached to segment C to the end attached to segment D. The brush F, which rests upon D, will convey the current to wire *h*, through which it will pass to the lamps or other apparatus in the circuit and return to wire g, and from here by brush E to segment C and back to the loop. When the loop reaches a position at right angles to the lines of force, the brushes will rest on the spaces between C and D. When the loop passes beyond this point, brush F will be resting on segment C, and E on segment D, which is just the reverse of their present relation. At this point the current in the loop will also reverse, hence the current in wires g h and the outside circuit will remain unchanged.

By this means the current is rectified, but it is not rendered uniform, owing to the fact that as the loop travels through the magnetic field in a circular path, the rate at which it cuts through the lines of force is not uniform, as is clearly shown by means of Fig. 14. In this the lines of force are represented by lines equidistant from each other, and the loop is shown in positions advancing by one-sixteenth of a revolution. If the rotation is uniform, these positions of the loop will represent equal intervals of time, and the lines representing the lines of force, being the same distance apart, will represent a uniform magnetic field. In passing from position A to position 1 the loop will cut one line, but from position 1 to position 2 it will cut two lines, and from 2 to 3 three lines, and from 3 to 4 four lines. The strength of the current developed in passing through each one of these arcs of the circle will be proportional to the number of lines of force cut. We can represent the strength of the current at the various parts of the revolution by means of a curve, such as shown in Fig. 15, in which the distances AD, DE, EF, etc., represent the arcs A-1, 1-2, 2-3, etc., of Fig. 14, and the vertical lines Dd, Ee, Ff, etc., the number of lines of force cut in passing through these arcs. If the curve above the line AC represents current flowing in one direction, a curve below this line will represent a current in the opposite direction, and the two curves, N and M, the latter shown in broken lines, will show the strength and direction of the current in the loop at all points during one revolution. The reverse current, M, is rectified by means of the commutator, and thus the real current is as shown by the curve N. N.

It will be noticed that at A B C the current is nothing, and these are the points where the loop is at right angles with the lines of force, hence the wire is moving parallel with them and there is no cutting. At G and G^1 the current is the strongest, and these are the points where the loop is parallel with the lines of force, in position 4, and therefore cuts them at the highest rate.

The pulsating character of the current, as shown in Fig. 15, can be overcome by using more than one loop and combining the currents generated by them into one. If two loops are used, and placed at right angles with each other, one will be developing the greatest current at the time when the other is doing nothing, as is indicated by the two sets of curves, N M, in Fig. 16. If three loops are used, separated from each other by 60 degrees, the three currents will have the relation shown by the curves A B C in Fig. 17.

These combined curves, shown in Figs. 16 and 17, do not show the real smoothing down of the pulsating currents effected by the use of two and three loops, except in a general way. In the next article the effect of these combinations will be more fully explained.

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Another Trans-Atlantic Line of Freight and Passenger Steamers.

Another transatlantic freight and passenger line will come into existence during the month, when the consolidated Wilsons, Furness-Leyland Line will commence operations. The service will be weekly between New York and Boston and London. The five ships, for which orders were placed when the combination of interests was agreed upon, are now nearly ready for sea. They will be known as the Victoria, Cleopatra, Cassandra, Burtecca, and Alexandra. All were built in the United Kingdom, the orders being distributed among East Coast, Belfast, and Clyde builders. A feature of the new line will be the carrying of only one class of passengers at a moderate fare for first-class accommodations. The new vessels are all of large dimensions of the type known as intermediate. This means that they will have large cargo capacity, with passenger trade as a secondary though not unimportant feature, and will be of moderate speed. A description of one of the new vessels is here given in part from the Engineer, London.

On Saturday, July 31, the S.S. Victoria was launched from the shipbuilding yard of Messrs. Furness, Withy and Co., Limited, Middleton, West Hartlepool. This vessel has been built to the order of The Wilsons and Furness-Leyland Line, Limited, and is intended for their Boston and New York passenger, cattle, and cargo trade. Unusual interest was centered in this event, as this vessel fs the largest ever built at the port. Her dimensions are as follows: Length over all, 490 ft.; beam, extreme, 52 ft. 3in.; depth moulded, 34 ft. 6 in.; with a deadweight carrying capacity of about 8,450 tons, and a measurement capacity of about 11,900 tons. She is built throughout of Siemens-Martin steel to Lloyd's 100 A1 class, although in many instances the scantlings are far beyond the society's requirements. She is built on the web frame principle, with cellular double bottom for water ballast, with all the latest appliances for filling and discharging the tanks. The hull is divided into nine compartments by means of eight watertight bulkheads. She has three complete steel decks, and in addition a shade deck above with a bridge 130 ft. long on top of it. Arrangements have been made for carrying about 700 head of cattle under the shade deck. The vessel will be rigged as a fore-and-aft four-masted schooner. The accommodation for the crew and cattlemen is placed under the shade deck forward. Accommodation for about 120 first-class passengers is to be fitted in the bridge and large deck-house.

The engines, which are being constructed by Thomas Richardson and Sons, Limited, are the largest yet built in the Hartlepools, and have been designed to suit the requirements of the heavy Atlantic trade. The diameters of the cylinders are 32 in., 54 in., and 90 in., by 60 in. stroke, on the three crank triple expansion principle, with a steam pressure of 190 lb. per square inch. The high pressure cylinder is fitted with a piston valve and the intermediate and low pressure with double ported slides, the cylinder supports consisting of massive cast iron divided columns. A separate centrifugal pump is employed for circulating water through the condenser, and the air pump is of Edward's design. In lieu of the ordinary feed pumps worked from the main engines a complete set of Weir's engines and pumps will be fitted, and the various auxiliaries in the engine room include large Pulsometer for pumping ballast tanks, Owen's feed donkey and fire pump, Morison's combined evaporator and winch condenser. The propeller is of the variable pitch type, the blades being of manganese bronze. Steam is supplied by two double and two single ended boilers, the latter being in the center and arranged back to back, either serving as an auxiliary in port. The boilers are fitted with Morison's suspension furnaces and Henderson's rocking fire-bars.

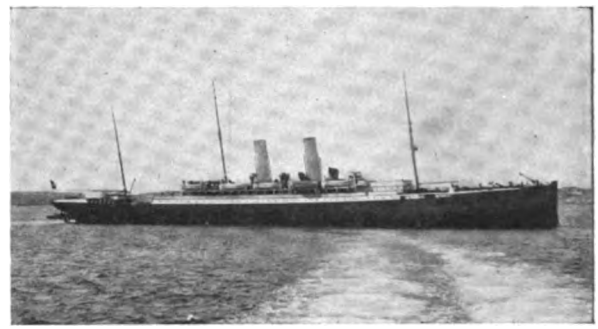
Work on the Grande Duchesse.

For several months the Babcock & Wilcox people have been at work on extensive alterations in the boilers of the Grande Duchesse, which has been lying at the shipyard, says the Newport News Daily Commercial. These boilers, it will be remembered, were put in on the order of the owners of the ship and against the best judgment of some of the best mechanics. They never have worked with that degree of satisfaction that has always characterized the work turned out at the shipyard here. At one time it was thought that the boilers would be taken out altogether. The Babcock Company, however, determined to make things satisfactory if possible, and to that end they have been making the extensive alterations necessary in the boilers without removing them from the ship. This work is very nearly completed and the craft will shortly go out on a run to test the repaired boilers.

Salvage Cases Recently Decided.

An award of $25,500 for salvage services has been made by the Admiralty Division of the English Courts in the case of the North German Lloyd steamship Spree, which was towed into Queenstown harbor July 8 by the Atlantic Transport liner Maine. The Spree was bound West, from New York for Bremen, with a large passenger list and full cargo, when her crank shaft broke, the after crank being fractured clear through. As she has no yards, she drifted out of the track of steamships until July 5, when she was sighted by the S.S. Maine, on a voyage from Philadelphia to London. The Maine took her in tow, the anchor cables being passed out through the hawse pipes of the Spree and secured to the towing hawsers. The weather was fine and the vessels made good progress until July 8, when, nearing Queenstown, the captain of the Spree decided to let go one of the hawsers, so as to have an anchor ready when the harbor was reached. This was done, but the remaining hawser soon parted, and a good deal of trouble was occasioned in securing fresh hawsers in position. The distance towed was 500 miles. The values of the vessels and cargoes were: For the Maine $226,425, and the Spree $425,000.

Another interesting salvage case decided was that of the Cunarder Cephalonia, which broke her tail shaft and was towed into Queenstown by the West India & Pacific Company's steamship Floridian. The award was $15,250.



S.S. SPREE IN QUEENSTOWN HARBOR AFTER MISHAP.

An award of $55,000 was made by the same court in case of the Pacific Steam Navigation Company's steamship Oratava, which was hauled off a shoal in the Red Sea, by a vessel of the Perim Coal Company. The value of the Oratava was given as $277,500, and of the cargo $495,000.

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DURING THE MONTH.

The Caspian, 2,747 tons, one of the Allan Line steamers built in 1870, was sold for $20,000.

The Chicago Ship Building Co. has booked a contract for a steel tow barge, 376 ft. long, 48 ft. beam, and 28 ft. deep.

The Compagnie Generale Transatlantique, better known as the French Line, has placed orders for two 22 knot steamships to ply between Havre and New York.

The new dry dock at Yokohama measures: Length, 351 ft.; breadth at entrance, 60 ft. on top and 45 ft. at sill, and depth, 35 ft. Another and larger dock is building.

An order for a new ferryboat has been placed with the Delaware River Iron Shipbuilding and Engine Works by the Brooklyn and New York Ferry Co. She will be built of steel and will be nearly 200 ft. long.

William Cramp Ship and Engine Building Co., of Philadelphia, has commenced work on a new steamship for H. M. Flagler. The new vessel will be about 250 ft. long and will run in the West India trade, connecting with the Flagler railroad lines.

An effort is to be made by the Russian Government to keep open the port of Vladivostock, Siberia, during the coming winter by the use of ice-breaking steamers, built on the Danish model. A description of such vessels will be found in this issue.

The Isle of Man paddle steamship Empress-Queen, illustrated and described in our June issue, is now running between Liverpool and Douglas. On her maiden voyage, with the engines making 40 turns, the passage of 80 miles was done in 3 hours and 40 minutes.

A report was started in the daily press that the whaleback Christopher Columbus was to be cut in two and taken to sea for service in the Alaska trade. This has been authoritatively denied, the owners stating that the vessel would continue in the Chicago-Milwaukee passenger trade.

A novel method of removing the propeller of a steamship was tried at Aberdeen recently. The S.S. Ohio was towed into dry dock for repairs, and to speedily remove the propeller charges of dynamite were used. These were very effective, but also damaged the dock floor and walls, and a suit for damages will likely result.

Another twin-hull, self-propelling garbage dumping boat for the city was launched at Nixon's shipyard in Elizabethport August 6. She is a sister vessel to the Cinderella, launched and tested some time ago. The new boat is called the Aschenbroedel and is 140 ft. long, 32 ft. beam, and can carry 300 tons on 8 ft. draught at a speed of 11 miles.

A sum of $1,750 has been divided between the officers and crew of the British S.S. Oceanic by the owners, in recognition of their services in replacing the tail shaft and propeller of the ship while at sea. While on a voyage from South Africa the steamer lost propeller and tail shaft, and the engineers decided to fit the spare one carried aboard. The vessel was tipped and the job done inside of nine days, in water infested with sharks.

The presence of the White Star liner Teutonic at the Jubilee review at Spithead as an armored cruiser occasioned much comment among the foreign naval officers present. Her guns had been put aboard at Liverpool with extraordinary rapidity upon her arrival after a voyage. An extract from the log of this ship shows a remarkable uniformity of speed. Runs made in June, 1895, 1896, and 1897, showed, respectively, average speeds of 20.11, 20.17, and 20.18 knots.

The steam yacht Presto, built from the designs of C. D. Mosher for J. Adolph Mollenhauer, of New York, was launched from the Ayer's shipyard at Nyack. She is 8 ft. 6 in. long and 9 ft. 6 in. beam. Her draught is only 2 ft., as she will be used for cruising in shallow water. Her machinery consists of a quadruple expansion engine with cylinders 6 in., 9 in., 12 in., and 16 in. dia. by 8 in. stroke, and a Mosher water tube boiler having 1,282 sq. ft. heating surface.

It is probable that the unfinished tunnel under the Hudson river will be completed if efforts to secure fresh capital are successful. The western extremity of the tunnel is at the foot of Fifteenth street, Jersey City, and the New York end will be at the foot of Morton street. The total distance is 5,400 ft., of which about 4,300 ft. are completed. The success which has attended the construction of the Blackwall tunnel under the Thames has caused a revival of the Hudson river project, which was originally begun in 1874.

The rush to the Klondike gold fields from Pacific coast points has caused a sudden demand for vessels to carry the mining parties. Every vessel sailing for Alaska recently has been loaded with freight and passengers. There has also sprung up a demand for river boats for inland navigation on the routes to the gold fields, and orders for several such craft have been placed with builders in the States. Some of these are of the knock-down type, and are to be shipped to Alaska in sections and there put into the water.

The progress being made in fast long-distance steaming is exemplified in the new mail carrying contracts made by the British Government with companies carrying to far eastern points. The new contracts come into operation February 1, 1898, and stand thereafter for seven years. The passage to India is to be shortened by two days and to South Australia by 4 1-2 days. The Peninsular and Oriental Steam Navigation Co. will receive $1,650,000 per annum for the services to India, China, and Australia. The Orient line secured a contract for a fortnightly service to Australia, touching at Colombo, for $425,000 per annum.

On July 22 the Monarch, the largest merchant steamship yet built in England, was launched at the yard of Swan and Hunter, Wallsend-on-Tyne, for Elder Demster & Co., of Liverpool, to trade to America. The vessel is 483 ft. long, 56 ft. beam, and 42 ft. 3 in. deep, and is built to the highest class at Lloyds for the 3-deck rule, with shelter deck for cattle. Her cargo capacity measurement is upwards of 18,000 tons, with 700 tons bunker capacity additional. The deadweight cargo capacity is 15,500 tons. She is fitted with a double bottom, in which 3,000 tons of water ballast can be carried. The machinery consists of a set of triple expansion engines with cylinders 28 1-2, 46 1-2, and 60 in. dia., and 54 in. stroke. Three boilers fitted with Howden's draught will supply steam at 180 pounds. Larger steamers have, of course, been built in Ireland and Scotland.

In the paper by P. Sigaudy, France, describing an instalment of water tube boilers to furnish 23,000 horse power, regularly on voyages, read before the International Congress in London, several particulars of interest were given. The installation refers only to one particular type of boiler, the "Normand et Sigaudy," and included 16 double ended boilers, to carry 220 lbs. pressure per square inch. The grate surface for each boiler was 95 sq. ft. or a total for all of 1,520 sq. ft. Rough heating surface for each, 4,600 sq. ft., or a total of 74,400 sq. ft. Each boiler had 1,700 tubes, or 27,200 for all. The volumes of steam and water were: Water, one boiler, 326 cu. ft.; all, 5,216 cu. ft. Steam, one boiler, 172 cu. ft.; all, 2,759 cu. ft. The weights were figured thus: 16 boilers, 590 tons; water in boilers, 146 tons; funnels, 100 tons, and the total, including all fittings, accessories, and spare gear, 938 tons. Figuring the coal consumption at 1 1-2 lb. per I. H. P. the combustion would reach 227 lb. per sq. ft. of grate surface. The weight of cylindrical boilers with 1,520 sq. ft. of grate surface was figured by the author to be about 1,700 tons.

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A new set of rolls has been put in Pembroke Dock Yard, England, the machine having a length of 29 ft. 6 in. The rolls are Bessemer steel forgings, and the upper one weighs 25 tons.

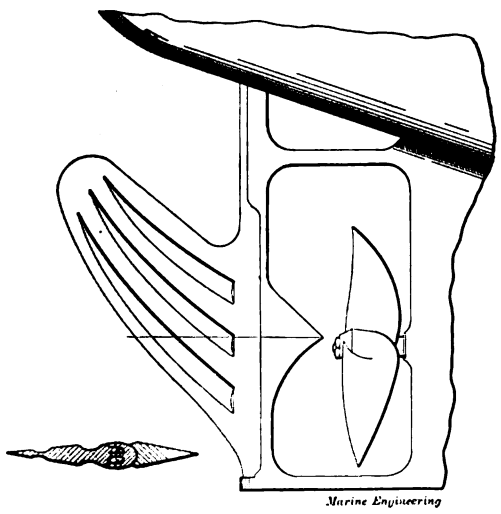
Bids for the construction of a new revenue cutter for the port of New York will shortly be called for by the Revenue Cutter Service. There is an appropriation of $175,000 available.

The firm of Harland & Wolff, the Belfast, Ireland, shipbuilders, is keeping up the record for big tonnage output. The total for this yard for the first six months of the year was 39,000 tons.

OBITUARY.

The death last month of Arthur Lozier, of the Bullock Electric Co., New York, was an exceptionally sad one. He was a man of fine physique, genial, magnetic, with hosts of friends. He was interested in all engineering and mechanical subjects, and thoroughly trained for the work he had undertaken. Upon finishing his education at Stevens Institute, he took up practical engineering subjects and made himself thoroughly conversant with all that goes to make a successful career in those lines. He became a member of the American Institute of Electrical Engineers, joined the New York Naval Militia, and in other ways connected himself with progressive movements. No young man could have been better prepared for a life of much usefulness, nor could one at the age of 23 have given promise of greater success.

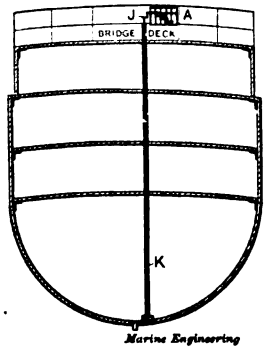
The death of J. K. Kilbourn, at Hartford, Conn., August 14, is announced. He was widely known among shipbuilders and owners as one of the most skilful designers of refrigerating machinery in this country or abroad. Mr. Kilbourn was a native of Connecticut, and in his earlier years of mechanical invention he, in company with his brother, E. E. Kilbourn, produced the Kilbourn knitting loom. In 1873 he went abroad as commissioner from the United States to the Vienna Exposition, and thereafter until 1890 spent much of his time abroad installing refrigerating apparatus on an extensive scale. In 1890 he returned home to supervise the placing of machines on the vessels of the American and Red Star lines on which Kilbourn plants are extensively and successfully used. His son, A. Gray Kilbourn, who was closely associated with deceased in carrying out the various contracts will in future conduct the business.



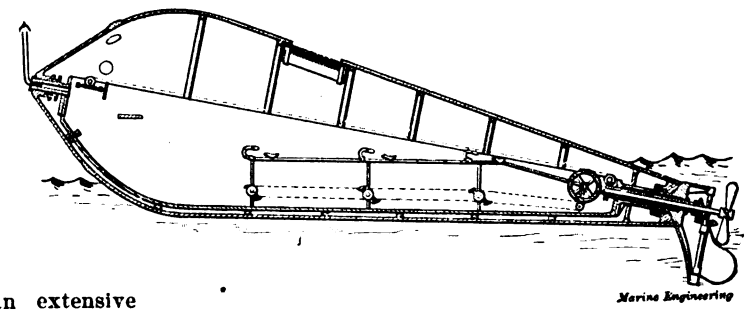
SELECTED PATENTS.

588,248—SPEED RECORDER. *William J. Smith, Victoria, Canada. Filed Feb. 15, 1895.*

In a speed-recorder for vessels, the combination



with the motor-wheel and the power-gearing driven thereby, of register-gearing driven by the power-gearing through the intermediacy of a worm having an adjustable thread and an indicator for the register whereby an adjustment of the thread may be made to establish the correct rate of transmission between the power-gearing and register-gearing and thus



standardize or calibrate the register. The motor-wheel being mounted upon a shaft extending fore and aft of the ship and having blades revolving partly within a dead-water chamber or pocket formed in the ship's bottom.

585,903—LIFE BOAT. *Reinhold Bethke and Bernhard Bethke, Milwaukee, Wis. Filed Jan. 28, 1897.*

A life boat comprising a ventilated outer shell of conoidal form having glazed ports and a hatchway that is provided with a suitable closure, a cradle trunnioned in the shell, a rudder having its post hung in arm extensions of the rear cradle-trunnion, a sleeve rotative in the trunnion and geared to the rudder-post, a steering mechanism in gear with the sleeve, a propeller having its shaft rotative in the sleeve, a power-shaft in gear with the propeller-shaft, a frame set in the cradle, pedal-driven crank-shafts mounted in the frame, seats and hand-bars on the frame, and link belt and sprocket-gear connecting the cranks with the power-shaft.

588,512—RUDDER. *Albert Vierl, Chicago, Ill. Filed July 27, 1896.*

A rudder comprising a blade or tongue, provided with longitudinal grooves or recesses, mounted upon a shaft and extending rearwardly at an upward incline. The combination with a rudder-frame provided with a concave rearward upright having a forwardly-extending triangular projection, of a rudder mounted in the frame as described; the upper edge of the blade being in alignment with the upper edge of the triangular projection.

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NEW PUBLICATIONS.

Cassier's Magazine for August is devoted exclusively to articles on marine subjects touching on almost every department of the shipbuilder's art. There are included articles of a descriptive and analytic character. These are written for the most part by well-known masters of their profession, in popular style, which should enable any intelligent reader to easily follow the author. The illustrations, both half-tone and line, are very numerous and of themselves are valuable for reference. The magazine contains 300 pages and includes such articles as: "Specialties of Warship Design," by Sir W. H. White; "Steamers for Shallow Rivers," by John I. Thornycroft; "The Modern Marine Engine," by Charles E. Hyde; "The Coaling of Steamships," by S. Howard Smith, and "The Naval Weakness of England," by Sir Charles W. Dilke. The price is 50c. per copy, and the office of publication, World Building, New York.

"A Chronicle of Books Relating to Steam Navigation, the Navy, and Allied Subjects." This is the title of a little pamphlet issued by Edward Baker, 16 John Bright street, Birmingham, England. To the collector of scientific books, or the head of an educational institution, who desires to complete a set of books on such subjects, this price list is of considerable interest. The oldest book of the lot dates back to 1681. From this to date there is a succession of works, many by famous authors. A brief description is given of each, which the publisher says has not been written "with the view of merely selling a book." The price of the pamphlet is 6 pence, postpaid.

CATALOGUES.

"The Merits of Lead Paints and Dixon's Silica-Graphite Paint Compared" is the title of a pamphlet received from the Dixon Crucible Co., Jersey City, N. J. This pamphlet is written largely because of the extended discussion of late concerning protective coverings for metal. Every user of paints for such purposes should send for a copy. Many striking illustrations are given, showing the advantages of paints other than red lead, an especially striking one being the bridges across the Chicago river.

Users of anti-friction metal should send for some of the blotters which the A. W. Cadman Mfg. Co., 63 Water street, Pittsburg, Pa., is sending to its friends and customers.

The lubricators, valves, oil injectors, and other devices manufactured by the Detroit Lubricator Co., Detroit, Mich., are very fully and completely illustrated and described in the 1897 catalogue just received. It comprises about 50 pages and is very fully illustrated, having in most cases from two to four illustrations on each page. The descriptive matter accompanying the cuts is very complete and altogether it is a most useful catalogue. Every user of such devices should send for a copy.

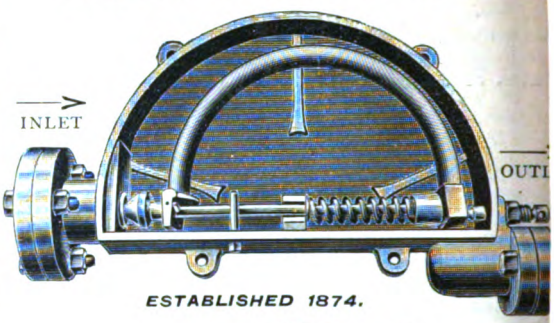
The stamped embossed sheet metal pleasure and ducking boats manufactured by W. H. Mullins, Salem, Ohio, are well illustrated and described in a catalogue just received. These boats are made of manganese bronze, aluminum, or galvanized steel, and each type is fully described.

The pocket size folder of eight pages just being distributed by the Peerless Rubber Mfg. Co., 16 Warren street, New York, has an excellent rainbow effect on the front page, referring especially to the Rainbow packing. The several other kinds of packing also manufactured by this company are well illustrated and fully described. These folders contain interesting matter for all users of packing.

A number of circulars have just been issued by the Lunkenheimer Co., Cincinnati, Ohio, describing and illustrating some of their new devices. These include the Champion rod oil cup, regrinding swing check

A Marine Trap

That Never Fails



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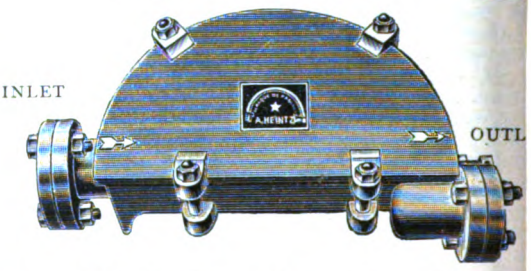

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